TROPICAL AGRICULTURE

January to December, 1931.

TRINIDAD:
PRINTED BY THE GOVERNMENT PRINTER,
GOVERNMENT PRINTING OFFICE,
PORT-OF-SPAIN.

1931.

TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. VIII No. 1. JANUARY, 1931. PRICE 6d.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183.

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities.

Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE COTTON CONFERENCE.

LAST August the Empire Cotton Growing Corporation organised a Conference of workers on problems related to cotton growing. An unusually large number of cotton workers were in England for the International Botanical Congress, and it was felt to be an excellent opportunity for a discussion of problems and an exchange of views. The British Cotton Industry Research Association kindly allowed the Conference to be held at the Shirley Institute, Didsbury, and appointed as delegates those members of their staff who were engaged on problems of direct interest to the grower. Over forty delegates attended representing the Empire Cotton Growing Corporation, the Shirley Institute, the Imperial College of Tropical Agriculture, the Colonial Agricultural Services, and other interested bodies, and having experience of cotton in almost every area in the British Empire where it is grown. A feature of the organisation which was somewhat unusual and singularly successful was that all papers were printed and circulated some time beforehand, and taken as read at the Conference. Each paper was however briefly introduced by the author, and then discussed.

A most interesting section of the agenda was that dealing with immaturity and "nep". Two papers were contributed by members of the staff of the Shirley Institute, and one by Mr. M.A. Bailey of the Empire Cotton Growing Corporation's staff in the Sudan. Here the industrial research worker and the agricultural expert met on common ground. Immaturity apparently results from unfavourable environmental conditions, such as severe water strain when the rains end suddenly and the crop is ripened in very dry weather. When immature hairs with little secondary thickening form a considerable proportion of the lint, they tend to roll up into knots or "neps" during spinning, and cause irregularities in the cloth and uneven dyeing. Immaturity is a common fault of Empire cottons, and probably results from the fact that the climate of Empire cotton producing areas is more rigorous than that of the areas in which most commercial varieties originated. The trouble is aggravated by the fact that the longer and finer the lint, the more susceptible it is to those influences which interfere with its maturing. The Shirley Institute representatives insisted that immaturity and liability to "nep" must be got rid of at all costs, and suggested sacrificing staple and fineness to some extent,

The agriculturists were equally definite that short staple cotton would not pay, and thought that the spinner might learn to spin immature cotton without making "neps." It was fairly generally agreed, however, that the problem is an agricultural one and must be solved in the field and not in the mill. While there were great differences of opinion expressed, several observations seemed to indicate that it is by no means impossible to combine good staple and good quality with freedom from "nep." In the first place, some cottons tested at the Shirley Institute have proved to be thin-walled without being "neppy." Secondly, it was stated in a later discussion that East African cottons have improved in maturity in the last few years, indicating that selection in favour of a plant better adapted to its environment is producing a variety better able to mature its lint. Mr. Sampson of Kew, pointed out that under extreme climatic conditions, varieties which put on their crop slowly often mature their lint better than those which put on a heavy crop in a short period. There is good reason to believe, therefore, that varieties may be bred which will be much better adapted to their environment and, therefore, much less liable to yield seriously immature cotton than those which are being grown at present. It may be noted in passing that shedding, so abhorred of all good cotton workers, may be a valuable aid to a plant liable to sudden severe environmental variations, in ridding it of fruit which it could not mature.

An interesting group of papers followed on the range of usefulness of a single variety, exchange of varieties for testing purposes, and the maintenance of the purity of a strain distributed to peasant farmers. The paper on the maintenance of purity of Ishan cotton in Southern Nigeria, showed how remarkably successful the Nigerian Agricultural Department has been in its co-operation with a group of native farmers for the production of pedigree seed. In Northern Nigeria the supply of seed has been undertaken by the Empire Cotton Growing Corporation at their seed farm at Daudawa, and a comparison of the results of the two methods after a number of years working should be instructive, although of course the type produced at the latter place is an upland cotton.

The second day's proceedings opened with two papers by members of the staff of the Shirley Institute on Uniformity of Cotton, and Methods of Correlating Strength of Yarn with Hair Properties, and the delegates welcomed wholeheartedly the opportunity of continuing the exchange of opinions between the Shirley Institute representatives and the agriculturists.

Two statistical papers followed. The first was by Dr. E. J. Maskell on Field Experiments, and included a strong plea for better co-ordination between the experimental programmes of different stations, with a view to obtaining comparable data on the range of conditions under which cotton is being grown, and on the reactions of the plant to these conditions. The second was by Sudan workers on a complex experiment to determine the inter-relationships of sowing date, spacing, water duty and nitrogen supply, in controlling the growth of the cotton crop, and gave a very good account of the design, execution and analysis of a modern agricultural experiment.

Among other subjects discussed were soil erosion and black arm disease.

A great deal of ground can be covered in two days steady discussion, and such a thorough airing of opinions and exchange of information can hardly fail to have its effect on future developments in cotton growing. Particularly valuable was the exchange of views between the agricultural representatives and the staff of the Shirley Institute, and the way in which members returned, both in session and at leisure, to the subject of nep—like dogs to a bone—showed clearly how helpful such a Conference can be.

Almost equally valuable were the discussions between men from different producing areas, and the establishment of personal contacts which will facilitate the exchange of information and ideas in future.

DISEASE-RESISTANT CANE.

A giant type of sugar-cane which grows 25 to 30 feet high in its native home, the island of New Guinea, is now making satisfactory growth at Canal Point, Fla., according to reports just received by the United States Department of Agriculture.

The cane in question belongs to a new species (*Saccharum robustum*) which has not yet been described botanically. It was located and brought back to the United States by Dr. E. W. Brandes, of the department, who made an exploration trip to New Guinea in 1928 in search of disease-resistant varieties.

Plants of the new species are vigorous growers and are resistant to many diseases which attack sugar-cane in this country. The sugar content of the new cane is rather low, and for this reason plans are being made to cross it with other plants having higher sugar content. This work will take several years.

In April, 1930, about 80 varieties of sugar-cane cuttings were sent to the Canal Point field station for trial planting. Before these cuttings could be planted in Florida they had to grow in quarantine at the Arlington Experimental Farm for one year to prevent introduction of new pests or diseases.—(*Jr. of Heredity*, Vol. XXI, No. 6.)

MYCOLOGICAL SERIES No. 4.

This Memoir (price 2*s*.) which has just been published can be obtained on application to the Editor, Imperial College of Tropical Agriculture, Trinidad, B.W.I. :—It is entitled "Macrophomina Phaseoli (Maub) Ashby in Trinidad" and is by J. West, B.S.A., A.I.C.T.A., and R. W. Stuckey, M.A., B.S.A., A.I.C.T.A.

LOW PURITY MASSECUITES.

Crystallisation in Motion of Low Purity Strikes.

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THE method of crystallising in motion low purity massecuites has been almost universally adopted in the sugar industry. The theoretical aspects of crystallisation-in-motion were studied by both Claasen[1] and Horsin-Deon[2] when these crystallisers were introduced into the beet sugar industry. Owing, most probably, to the lack of precise information as to the solubility of sucrose in the presence of the normal impurities of the sugar-cane juice, similar quantitative investigations have never been carried out for the crystallisation of the various massecuites dealt with in the sugar-cane industry. Thieme[3] has recently investigated the solubility of sucrose in cane juices and has published saturation coefficients which enable the solubility of sucrose in a cane syrup to be calculated at any given purity. These saturation coefficients have been used in the present study of the crystallisation-in-motion of low purity massecuites. It is proposed to elaborate the theoretical aspects of crystallisation-in-motion and to indicate certain deductions which can be drawn from the preliminary experiments undertaken.

The chief factors affecting the velocity of crystallisation of sucrose from solution in the mother liquor of a massecuite are the purity, supersaturation and viscosity of the mother liquor. Savinoff[4] has recently pointed out that the velocity of crystal movement relative to the mother liquor is another important factor influencing the velocity of crystallisation. As it is intended to deal only with the final low purity strikes, the effect of purity need not be considered in this paper. Kucharenko[5] has shown that the velocity of crystallisation of sucrose from solution increases rapidly with the supersaturation. Both Claasen and Horsin-Deon have pointed out that the crystallisation of a sucrose syrup can be considerably accelerated by the reduction of the viscosity of the syrup. As the viscosity of a sugar solution rises with supersaturation, it follows that the two factors must be mutually antagonistic.

Although it is desirable that sucrose shall crystallise readily and rapidly from the mother liquor, it is important that this crystallisation shall take place under strictly controlled conditions so that all sucrose crystallising from solution shall deposit on the surface of crystals already present. If sucrose should deposit in the form of new crystals or false grain, curing of the massecuite will be hindered and much of the fine grain will pass through the centrifugal gauze with a consequent loss of sucrose in the molasses. Hence those conditions of supersaturation and viscosity of the mother liquor must be determined and maintained which will give the greatest recovery of sucrose as crystals in as expeditious a manner as is possible under conditions which preclude false grain formation.

A factor which will modify these conditions of supersaturation and viscosity to a greater or lesser degree will be the area of crystal surface exposed to the mother liquor. This factor is a very important one and has never been considered in any quantitative way. The non-recognition of this factor may prove the main reason why such variable results are reported by those investigators who have carried out experiments on the rapid cooling of massecuites. It is hoped to obtain some quantitative data on this factor in future work. In the experiments described in this paper the number of crystals are in the order of 20,000 per cubic centimetre of the final massecuites.

1. The Supersaturation of the Mother Liquor.

The supersaturation of the mother liquor of a massecuite will be affected by two main factors, *viz.*, concentration and temperature. At a given temperature the supersaturation of the mother liquor increases with the concentration of sucrose in solution. At a given concentration of the mother liquor the supersaturation increases as the temperature decreases.

(*a*) *Concentration.*

In the boiling of massecuites in the pan the concentration of the mother liquor is maintained at certain definite supersaturations during the actual drawing in of syrup or molasses, but before striking the massecuite from the pan the concentration and supersaturation of the mother liquor are raised. This final concentration necessarily increases the supersaturation and hence the velocity of crystallisation, so that more sucrose will be forced out of solution and, as would be expected, the degree of concentration attained has a considerable effect on the purity of the mother liquor. In Table I figures are given for two final low purity strikes which were boiled respectively to 93.5 and 95.5 Brix.

Table I.

Massecuite.		Mother Liquor (at time of striking).		Crystal Sugar in Massecuite (at time of striking).
Brix.	True Purity.	True Purity.	Coefficient of Supersaturation.	Per cent.
93·5	63·5	56·6	1·13	13·95
95·5	62·9	48·7	1·25	24·68

These figures illustrate the marked effect which concentration of the final massecuite has upon the supersaturation of the mother liquor and the percentage of crystal sugar in the massecuite. This principle is a well recognised

one and is emphasized by Geerligs.[6] The figures obtained in this investigation indicate that the supersaturation of the mother liquor in the concentrated low purity strikes is lower than is generally recognised. Deerr[7] considers that the coefficient of supersaturation of the mother liquor of low grade products when dropped from the pan should be between 1.5 and 1.6, but it is very doubtful whether such high supersaturations are obtained in practice.

It is of interest to compare the sucrose status of the two massecuites given in Table I. If it is assumed that 20 tons of massecuite are discharged from the pan then, from the data collected, it can be calculated that the 93.5 Brix massecuite will contain 2.79 tons of crystal sugar and 17.21 tons of mother liquor. The mother liquor will contain 8.3 tons of sucrose of which 0.96 tons will be in supersaturated solution.

In the case of the 95.5 Brix massecuite, there will be 4.94 tons of crystal sugar and 15.06 tons of mother liquor when the massecuite is discharged from the pan. It can be further calculated that the mother liquor will contain 6.33 tons of sucrose in solution of which 1.27 tons will be in supersaturated solution.

These figures afford a good demonstration of the fact that the extent to which the concentration of the massecuite is carried before its discharge into the crystalliser has a very considerable influence on the crystallisation of sucrose from the mother liquor.

Similar results to those cited have been obtained by Skorbilin[8] for second beet massecuites. Skorbilin concludes that the main crystallisation of massecuites takes place in the vacuum pan and that this crystallisation cannot be subsequently done in the crystalliser.

(*b*) *Temperature.*

The solubility of sucrose decreases with the temperature and hence the massecuite is allowed to cool in the crystalliser so that more sucrose may be crystallised from the mother liquor.

Various types of crystallisers have been used in the beet sugar industry which allow the rate of cooling of the massecuite to be controlled. In the cane sugar industry the U-shaped crystalliser equipped with some kind of stirring device, but not fitted with any method of cooling control, is the main type in use. Deerr[9] states that in cane sugar houses excellent results may be obtained with an uncontrolled rate of cooling. In the past few years considerable publicity has been given to the La Feuille crystalliser[10] in which the cooling of the massecuite is carried out rapidly. Various papers have since been published on this subject of rapid cooling of cane sugar massecuites and the results appear to be somewhat conflicting. Walker[11] obtained satisfactory results at one factory in Porto Rico by introducing cooling coils into a U-type crystalliser and cooling the massecuite from 24 to 36 hours, but unsatisfactory results were reported from another central with similar methods. Walker considers that his results demonstrate the value of crystallisers capable of rapid cooling especially in a central lacking crystalliser capacity. Van Nes and Khainovsky[12] concluded after a thorough investigation of the La Feuille crystalliser that the use of this crystalliser for first massecuites could hardly prove remunerative and that for final massecuites its installation is only called for when, owing to lack of sufficient room, it is necessary to have a crystalliser plant with an increased output. La Feuille[13] describes the operation of two La Feuille pans in a central in the Philippines and states that the final massecuite is cooled in three to six hours. Warren[14] has carried out experiments with a La Feuille crystalliser and suggests cooling the final massecuite to 33° C. in 12 hours and then raising the temperature to 60° C. before centrifuging.

The present study of the sucrose status of low purity massecuites during the cooling process was carried out in the usual U-type crystalliser which was fitted with a spiral stirrer but no cooling device. This investigation was partly undertaken as a result of an article by Salinas[15] on the elimination of crystallisers in which figures are quoted to show that considerable inversion of sucrose takes place during the cooling of massecuites in crystallisers. It need hardly be said that these observations are original and controvert much experimental work by Geerligs[16] and others who have previously shown that no inversion of sucrose takes place in the crystalliser. The results of our analyses which are given in Table II are in accord with the classical work of Geerligs and show no support for the contention of Salinas. This is perhaps of particular interest in view of the fact that the reaction of the diluted massecuite which was determined electrometrically gave pH 6.2. At this reaction some slight inversion may have been suspected after five days in the crystalliser.

Table II.

Time.	Brix.	Polarization.	Apparent Purity.	Dry Matter.	True Sucrose.	True Purity.
At discharge	95·5	51·5	53.9	89·62	56·08	62·57
12 hours later	95·5	51·5	53.9	89·62	56·38	62·91
24 do. do.	95·35	51·75	54.3	89·22	56·14	62·91
36 do. do.	95·4	51·9	54.4	89·28	56·50	63·27
*60 do. do.	94·9	47·25	49.8	88·60	52·54	59·29
84 do. do.	—	—	—	88·79	55·89	62·95
108do. do.	95·4	52·0	54.5	89·54	56·21	62·77
132do. do.	95·1	51·25	53.9	89·40	56·04	62·68

The effect of cooling on the exhaustion of the mother liquor in the crystalliser has been investigated by the separation and analysis of samples of mother liquor over different time intervals. These analyses made possible the calculation of the coefficients of supersaturation

* This sample was taken after stirring had ceased for 12 hours and the lowering of the purity is due to the settling out of crystals.

THE COLLEGE FARM BUILDINGS.

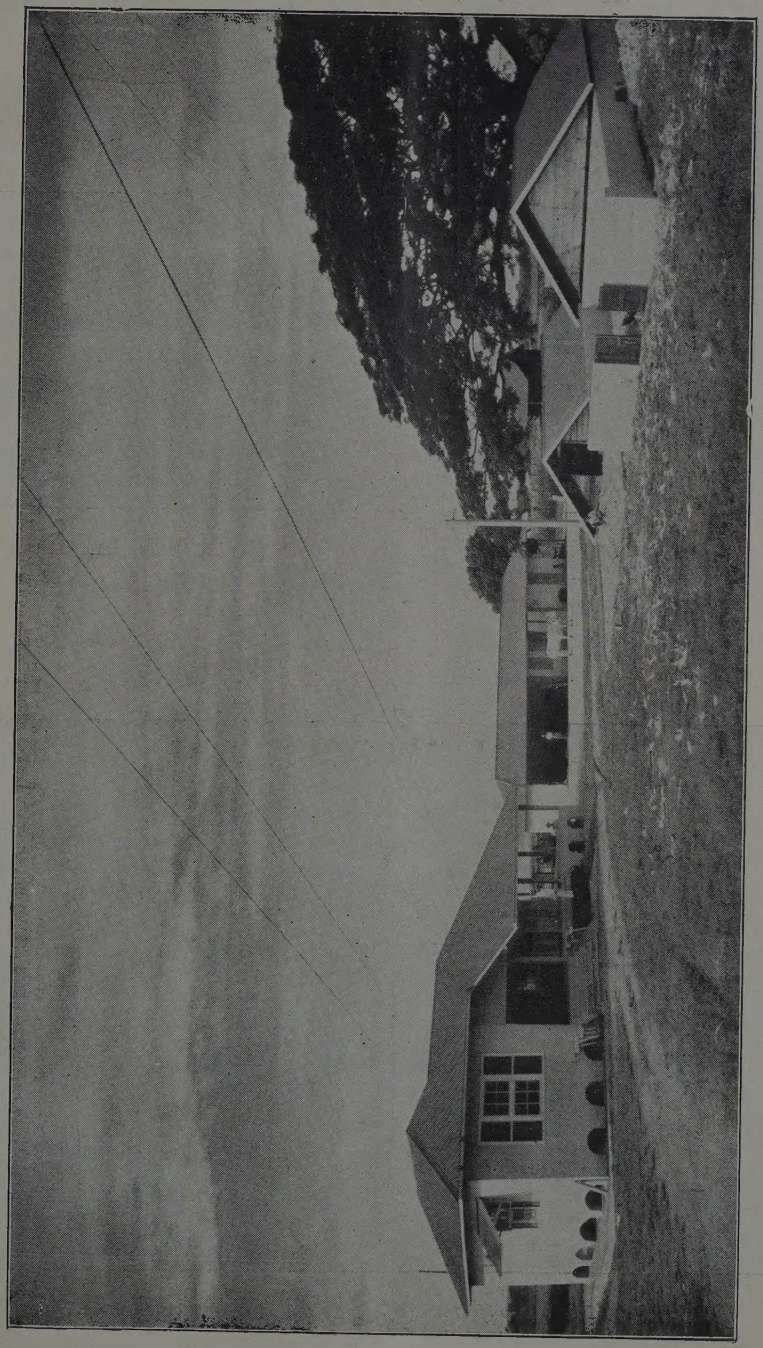

FIG. 1.—*General view of the College Farm Steading from the N.*

THE COLLEGE FARM BUILDINGS.

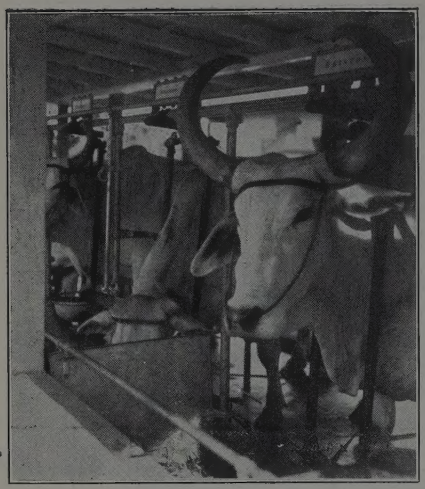

FIG. 2.—*Stanchions showing manger divisions, water-bowls and name plates.*

FIG. 3.—*Rear view (from N.E.) of new cattle byre.*

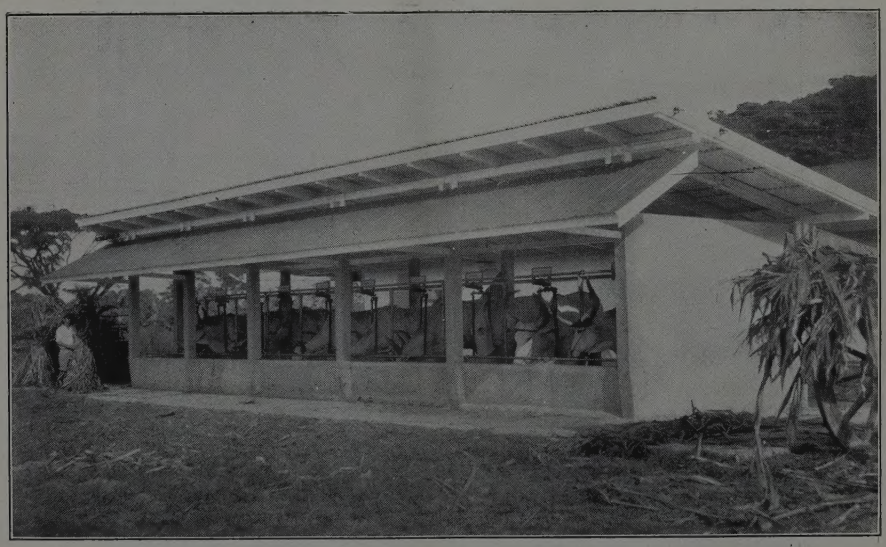

FIG 4.—*Front view (from S.E.) of new cattle byre for ten animals.*

of the mother liquor and the percentage of crystal sugar in the massecuite during the period that the massecuite remained in the crystalliser. A typical example of such a series of analyses is given in Table III.

Table III.

Time.	Dry Matter	True Purity	Temperature of Massecuite.	Coefficient of Supersaturation.	Per cent. Crystal Sugar.
At discharge ..	86·51	50·26	68	1·270	24·70
2 hours later..	86·33	48·94	66	1·221	26·34
12 do. do. ..	85·60	46·40	60	1·223	29·34
24 do. do. ..	85·11	44·47	52	1·236	31·47
36 do. do. ..	84·37	43·34	46	1·227	32·63
48 do. do. ..	84·20	42·30	42	1·225	33·69
60 do. do. ..	84·27	41·53	38	1·258	34·42
72 do. do. ..	84·26	40·72	36	1·262	35·16
84 do. do. ..	83·94	40·01	35	1·246	35·84
118do. do. ..	83·90	39·81	32	1·253	36·02

The temperature of the massecuite, the coefficient of supersaturation of the mother liquor and the percentage crystal sugar in the massecuite at different time intervals are shown in Fig. 1.

One of the striking facts brought out by these figures is the constancy of the coefficient of supersaturation during the entire period of cooling in the crystalliser. The crystal sugar increased during this period from 24.70 per cent. to 36.02 per cent. and it follows that the additional sucrose which crystallises from the mother liquor was due entirely to the fall in solubility of the sucrose in the cooling mother liquor and not to any reduction in the supersaturation.

The amount of sucrose crystallising from the mother liquor during each 12 hours and the mean temperature of the massecuite during these

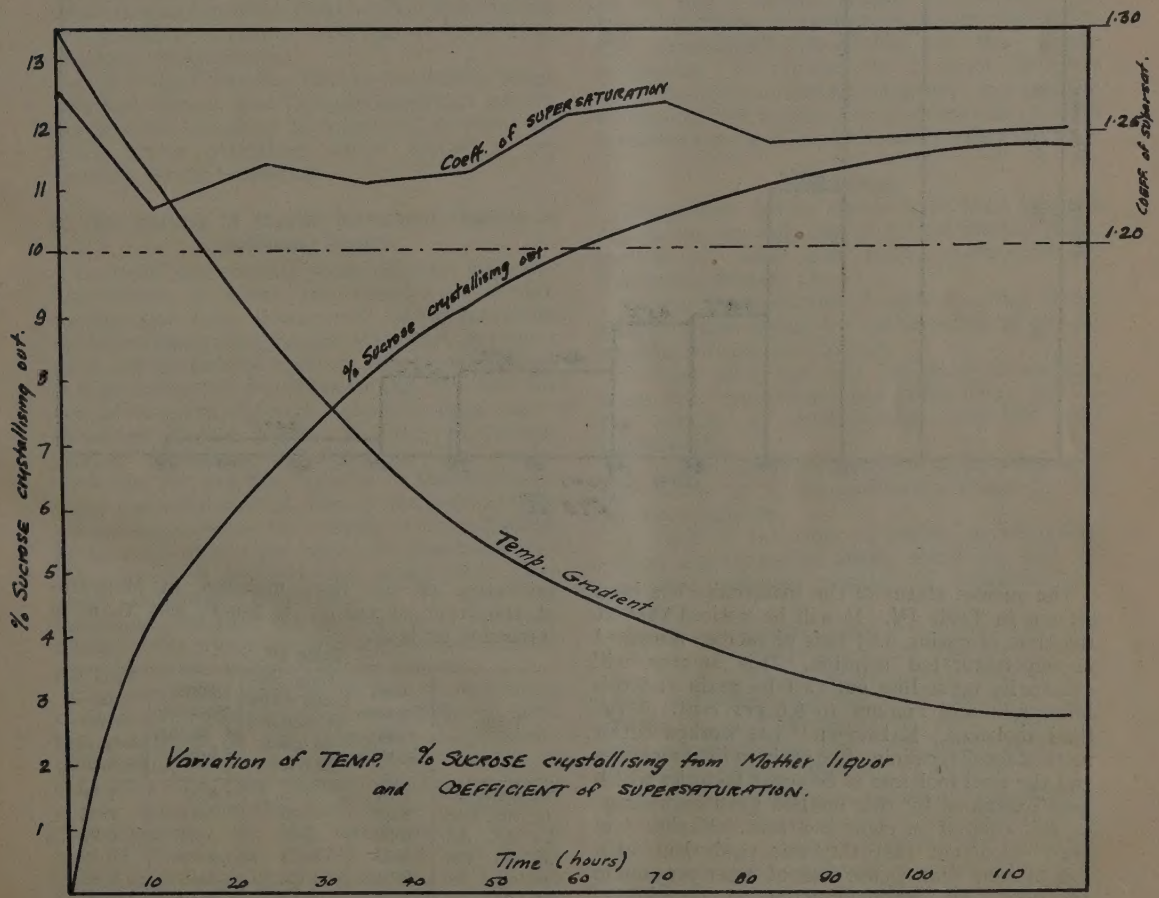

FIG 1

time intervals are set out in Fig. 2. Since it has been shown that the coefficient of supersaturation remained more or less constant during the whole of this period, it is obvious from Fig. 2 that the temperature which, in this case, will be the only factor controlling the viscosity of the mother liquor, has a very big influence on the velocity of crystallisation. Sandera [17] has shown that a definite temperature range exists within which crystallisation can take place. This range is controlled by the temperature at which the solution ceases to be supersaturated at one extreme and by the temperature corresponding to the viscosity at which crystallisation can begin on the other. It is evident from Fig. 2 that below 35° C. and under the conditions already defined, the viscosity of the mother liquor is beginning to reach the limit at which crystallisation ceases for all practical purposes. It is also apparent that there is a big drop in the velocity of crystallisation when the temperature falls below 60° C.

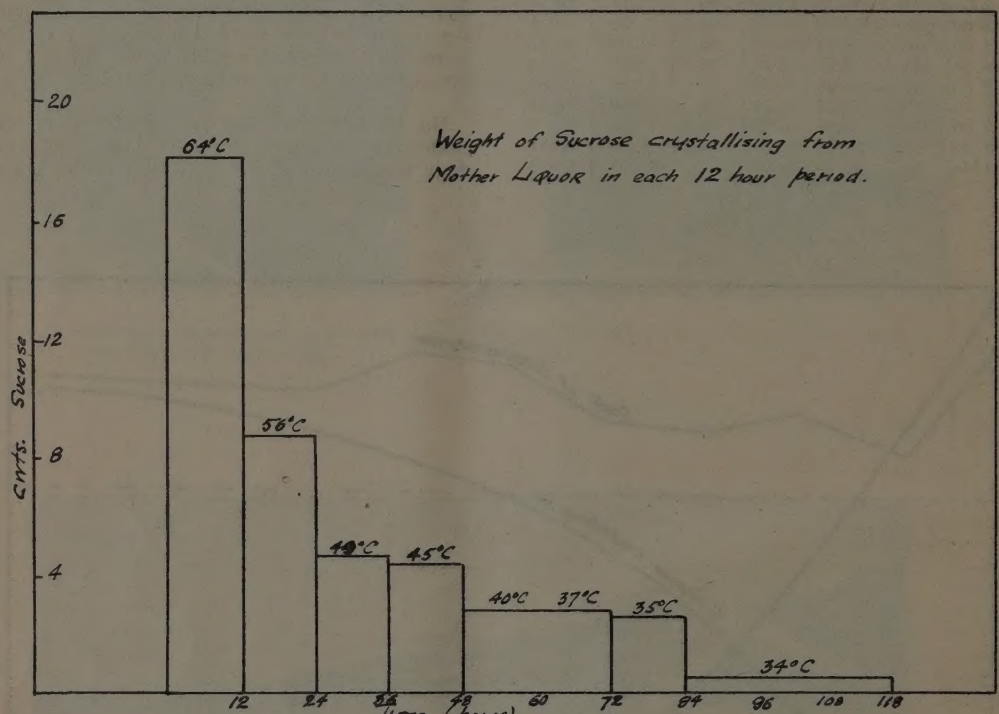

FIG. II

The sucrose status of the massecuite has been set out in Table IV. It will be noticed that at the time of curing 0.85 tons of sucrose remained in supersaturated solution. This sucrose will eventually crystallise out as false grain and this false grain will amount to 6.6 per cent. of the final molasses. Kalshoven [18] has worked out a method for determining fine grain in final molasses and the final molasses of 80 sugar factories which were examined by this method gave an average crystal content of eight per cent. Harloff [19] in 1919 calculated that this was equivalent to a loss of more than 35,000 tons of sugar per annum to Java. An examination of 18 samples of Mauritius molasses by Tempany [20] showed that the average fine grain content was only 1.18 per cent. It is evident that the supersaturation of the final molasses in Mauritius at the time of curing is much less than in Barbados or Java.

Table IV.

Time.	Tons Sucrose as Crystals.	Tons Sucrose Crystallised out in each 12 hours.	Tons Sucrose in Mother Liquor.	Tons Sucrose in Supersaturated Solution.
At discharge	4·94	—	6·51	1·39
12 hrs. later	5·87	0·93	5·57	1·02
24 do. do.	6·29	0·42	5·14	0·98
36 do. do.	6·53	0·24	4·73	0·88
48 do. do.	6·74	0·21	4·56	0·84
60 do. do.	6·88	0·14	4·49	0·92
72 do. do.	7·03	0·15	4·40	0·92
84 do. do.	7·17	0·14	4·23	0·83
118 do. do.	7·20	0·03	4·19	0·85

2. The Viscosity of the Mother Liquor.

Claasen [21] in experiments controverting the mechanical theory of molasses formation has shown that the viscosity of a sugar syrup does not *prevent* sucrose from crystallising from solution, but it does retard the rate of crystallisation. He also shows that the two main factors governing the viscosity of sugar syrups are temperature and concentration of sucrose. Claasen [22] considers that the increases in the coefficient of supersaturation have much greater effects on the viscosity of sugar syrups than similar increases in the non-sugar content.

Claasen [22] has determined the variation of viscosity with temperature for a concentrated molasses and shows that the curve is almost horizontal from 10 to 35° C., but inclines towards the vertical at 70 to 80° C. Kucharenko [23] in more recent experiments has determined the effect of both supersaturation and temperature on the viscosity of pure sucrose solutions. His results confirm the findings of Claasen and in addition bring out the fact that similar increases in supersaturation have a much greater effect in increasing the viscosity of sucrose solutions at lower than at higher temperatures.

It is evident therefore that in the factory where economy of space and time are important factors, the greatest relative recovery of sucrose will result under conditions which favour a low viscosity for the massecuite.

3. The Velocity of Crystal Movement relative to the Mother Liquor.

Savinoff [4] has recently described some ingenious experiments in which the velocity of crystallisation has been determined under conditions (*a*) where the crystal remains stationary in respect to a supersaturated mother liquor and sucrose is deposited solely by diffusion and (*b*) where the crystal is given different velocities in a supersaturated mother liquor in order to prevent sucrose deposition by diffusion. His results show that rotating the crystals in the supersaturated mother liquor at 100 or more revolutions per minute increases the velocity of crystallisation by as much as 500 per cent. He concludes that the velocity of crystallisation which takes place under industrial conditions is far from the maximum and that the application of intensive mixing in the crystalliser would give a considerable increase in the velocity of the process.

The conditions existing in the crystallisation of low purity massecuites are very different from the conditions of the laboratory experiments of Savinoff where four crystals are rotated in an excess of a pure sucrose solution possessing a low supersaturation and hence a relatively low viscosity. In the investigations carried out at Carrington Factory there were about 20,000 crystals per cc. of massecuite and it can be calculated from the figures given elsewhere that at the time of striking into the crystalliser the average crystal will weigh 0.018 m. grm., and at the end of crystallisation 0.027 m. grm. Utilising Thieme's relationships between weight and size for sucrose crystals, these average crystals will measure 0.26 m.m. and 0.30 m.m. respectively. If it is assumed that the crystals are scattered uniformly throughout the massecuite, it can be further calculated that 1 cc. will contain 20,000 cubes of 0.05 cm. m.; the side of each such cube will measure approximately 0.37 m.m. It therefore follows that the thickness of mother liquor between crystals is in the order of 0.1 mm. Owing to the high supersaturation of this mother liquor the viscosity is high and it will be difficult to obtain free movement of the crystal relative to its surrounding film of mother liquor. This means that under industrial conditions where large numbers of small crystals are present per unit volume of massecuite, the deposition of sucrose from the mother liquor in the crystalliser will be mainly by diffusion. The analyses in Table II, however, show that when stirring ceases in the crystalliser there is a lowering of purity in the surface massecuite owing to a settling out of crystals by gravity. This definitely proves that a certain amount of movement of crystal relative to mother liquor is possible in the crystallisation-in-motion of low purity massecuite. It remains to be seen therefore whether, under industrial conditions, it is possible to increase the velocity of crystallisation by more intensive mixing of crystals with mother liquor.

Discussion.

The salient points which have been brought out in the investigation of the crystallisation-in-motion of final low purity massecuite at Carrington Factory are :—

1. That the coefficient of supersaturation of the mother liquor during the entire period of cooling remains between 1.22 to 1.25.

2. That after the first 12 hours of cooling, when the temperature has fallen below 60° C., the velocity of crystallisation decreases very considerably.

3. That when the temperature of the massecuite falls below 35° C., crystallisation ceases for all practical purposes.

4. That at the time of curing, crystallisable sucrose amounting to nearly seven per cent. of the final molasses remains in supersaturated solution.

In discussing these points it is intended to show how, by a consideration of the theoretical treatment which has been outlined, the present method of crystallisation can possibly be improved and, further, to suggest alterations which might be tried out in practice and which would appear to lead to a greater recovery of sucrose.

1. *Improvement of present method of crystallisation.*

It has been shown that it is very important to discharge the massecuite from the pan at as high a concentration as possible. This ensures a greater crystallisation of sucrose in the pan and will also result in a relatively high supersaturation of the sucrose in solution in the mother liquor. This high supersaturation will necessarily entail

a high viscosity which will tend to retard the velocity of crystallisation. The investigations of Kucharenko [23], however, show that if the temperature of the mother liquor is high the effect on the viscosity of increasing the supersaturation of the sucrose in solution is relatively small. Kucharenko's results are supported by the observations made in the present investigation. Since at similar supersaturations of the mother liquor the effect on the viscosity and hence on the velocity of crystallisation is so great when the temperature falls below 60° C. (*vide* Fig. 2), it would appear logical to suggest that the temperature of the massecuite should be maintained at the striking temperature until there has been a considerable reduction in the supersaturation of the mother liquor. As Kucharenko has shown, the effect of supersaturation on the viscosity of the mother liquor at such a temperature will be relatively small and hence the velocity of crystallisation will be relatively high. Reference to Table IV shows that, at the time of discharge of the 20-ton massecuite from the pan, 6.5 tons of sucrose were dissolved in the mother liquor of which 1.4 tons were in supersaturated solution. A considerable amount of crystallisation can thus take place without change of temperature. In the 20-ton massecuite under consideration, a drop in the coefficient of supersaturation from 1.27 to 1.1 would result in about 0.85 tons of sucrose crystallising from the mother liquor. This crystallisation of sucrose from the mother liquor will effect a lowering in the viscosity but the effect of a lower viscosity of the mother liquor on the velocity of crystallisation will be offset by the reduction in the supersaturation. It may therefore be found that when the supersaturation has decreased to say 1.1, the velocity of crystallisation can be increased by cooling and there is little doubt that, with the low supersaturation of the mother liquor, this cooling could be carried out rapidly.

As shown in Table III, the mother liquor of a cooled massecuite is considerably supersaturated and although this sucrose is theoretically recoverable, it is lost under practical factory conditions because there is insufficient time available to allow crystallisation to go to completion. A recognition of this fact suggests means for facilitating the curing of such a massecuite. For instance, with the supersaturation existing in the cooled mother liquor shown in Fig. 3, the temperature of the massecuite could be safely raised from 32° C. to 50° C. without fear of dissolving grain, *i.e.*, without undersaturating the mother liquor. This method would appear much more advantageous than the more usual method of adding water to the crystalliser, since in the former case the viscosity of the massecuite is lowered not only by a reduction in the supersaturation of the mother liquor but also by the increase in temperature.

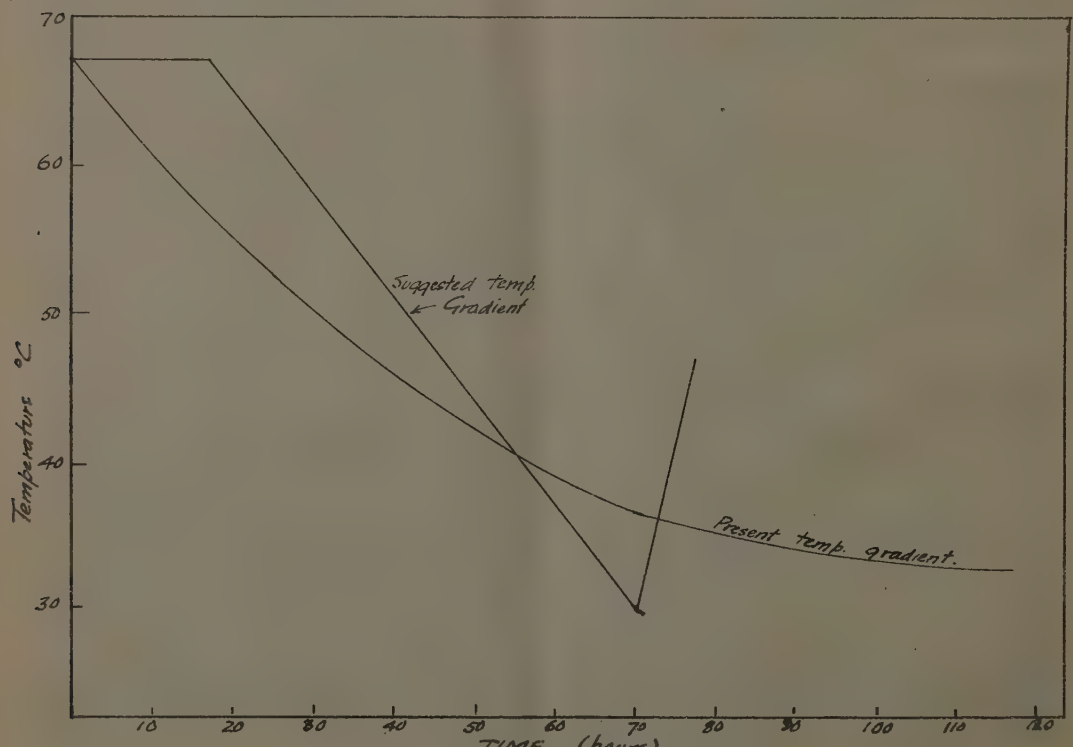

FIG III

In order to control the temperature of the massecuite on the lines suggested it would be necessary to fit coils into the U-type crystalliser so that hot or cold water could be circulated through the massecuite as desired. The temperature gradient suggested for cooling a low purity massecuite as contrasted against the present method is shown in Fig. 3.

2. *Possible further development.*

At Carrington Factory it is customary to strike the low purity massecuites at about 95.5 to 96° Brix; and the temperature of the massecuite is then about 68° C. and the supersaturation of the mother liquor is approximately 1.27.

As already stated Claasen [22] has shown that below 70° C. the effect of equivalent reductions in temperature has very much greater effects on the viscosity of sucrose syrups than similar reductions above 70° C. The effect of viscosity on the velocity of crystallisation could therefore be diminished if the massecuite was discharged from the pan at a higher temperature than 68° C. It is evident, however, that no additional recovery of sucrose could be obtained by raising the temperature of the massecuite before striking since such an operation would merely reduce the coefficient of supersaturation.

Additional recovery of sucrose could be effected if the temperature of the massecuite were raised and the supersaturation of the mother liquor were kept constant by raising the concentration of the massecuite. In adopting such a method in practice there would be no necessity to boil the massecuite at a high temperature throughout. It would be sufficient to boil in the usual manner until the massecuite would be normally discharged. Instead of discharging the massecuite, boiling would be continued and the vacuum would be gradually lowered as the concentration increased so that the supersaturation of the mother liqour remained constant. This operation could be controlled, after working out the necessary tables, with the aid of the Zeiss industrial refractometer. The massecuite would thus be maintained at a high temperature for a relatively short time and any danger due to overheating would be minimised.

These suggestions are deduced from theoretical considerations and are to be regarded as the lines on which it would be advantageous to carry out future investigations rather than as recommendations for application to immediate practice.

The temperature of the massecuite could be raised to say 80° C. before striking according to the method outlined in the previous paragraph. Since it is intended that the coefficient of supersaturation of the mother liquor of the discharged massecuite shall be approximately 1.27 as at present, it can be calculated that, in the case of the massecuite shown in Table III, in order to raise the temperature from 68° C. to 80° C. it will be necessary to increase the true dry matter of the mother liquor from 86.5 per cent. to 88 per cent. and, as the concentration increased, the vacuum in the pan would be decreased from 26½ inches to 24½ inches. The massecuite would thus be discharged from the pan at about 97.5 Brix and at a temperature of 80° C.

The solubility of sucrose in water at 80° C. and at 68° C. is 362.2 and 313.2 respectively so that cooling under similar conditions the massecuite at 80° C. has a potential extra yield of 49 parts of sucrose per 100 parts of water. Assuming that this potential yield would be recovered as crystals, the extra recovery would amount to about 0.85 tons sucrose on the basis of a 20-ton massecuite.

The cooling of the massecuite in the crystalliser would be carried out according to the optimum curve featured in Fig. 3, except that it would be advisable to reduce the striking temperature to 68-70° C. and maintain it at this level until the supersaturation had been sufficiently reduced. By so doing the tendency to froth fermentation would be minimised and, as has been shown, the velocity of crystallisation at 68° C. is sufficiently rapid.

It would appear that the greatest danger which is likely to result from the method which has been outlined will be the tendency to froth fermentation. Little work has yet been done on this subject and the cause of froth fermentation has not yet been completely elucidated. According to Spencer,[24] Kraisy explains the phenomenon by the reaction between invert sugar and amino acids. Ambler [25] has investigated the reaction between glucose and amino acids and concludes that it is improbable that this reaction is the cause of the evolution of gas during the froth fermentation of molasses. If however, gas is produced by any other means he considers that the melanoidins which are formed in the above reaction by virtue of their effect on surface tension will be a factor contributing to the formation of froth. Brown's [26] conclusions are similar to those of Ambler with reference to the reaction of glucose and amino acids. He considers that the breaking up into acid decomposition products of the unstable compounds formed by the action of lime upon reducing sugars is chiefly responsible for the destructive changes produced. This subject deserves further investigation and it is possible that a solution of the causes of froth fermentation will lead to suggestions whereby it may be prevented.

It is hoped in the coming crop season to try out the suggestions which have been outlined for the crystallisation of low purity massecuites. It is contended that these conditions favour the most rapid crystallisation and would result in a greater recovery of sucrose from the molasses.

Summary.

The theoretical aspects governing the crystallisation of low purity massecuites have been discussed and certain suggestions which appear to favour a more rapid and complete crystallisation of sucrose have been put forward.

Acknowledgments.

The author wishes to express his thanks to the management of Carrington Factory where the experiments described in this paper were carried out. He is also desirous to acknowledge the ready assistance rendered him by Mr. F. Hutchins who was responsible for most of the analytical work described.

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COLLEGE MEMOIRS.

The following can be obtained on application to the Editor:

Economic Series:

No. 1.—The Sugar Industry of the British West Indies and British Guiana, with special reference to Trinidad	C. Y. Shephard	1*s.*

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No. 2.—Experiments with Final Molasses ..	J. A. McDonald	6*d.*
No. 3.—Sampling of Cane in the Field	J. G. Davies	6*d.*

THE COLLEGE FARM BUILDINGS.

OLD students will be interested to see the development which has taken place in the last two years in providing the Agricultural Department of the Imperial College with accommodation for its work. This may be judged from the illustrations. In the left foreground of Fig. 1 will be seen the main building, which includes on the left the students' laboratory, the field office on the right, and a storeroom in the centre. Two drying floors or barbecues, with sliding roofs are seen to the right. In the background, beyond the cement threshing floor, is a long shed with accommodation for implements. This contains also a storeroom, engine room, feed preparation and storeroom, and cover for a chaff-cutter. Behind this is another lean-to implement shed, while in the extreme background can be made out the new cattle byre, further views of which are shown in the other photographs. This offers some points of interest, as little experience was available as to the suitability of stanchions of this type for working animals. The iron work was made by Messrs. Beatty Bros., Ltd., of Fergus, Canada, to a special specification, as the head-rail had to be raised to a height of four feet seven inches, instead of the standard four feet three inches, and the stanchions lengthened in proportion. The depth of these stalls varies from five to six feet, which has been found, if anything, slightly too large; the width of each stall from three feet six inches to four feet six inches. Water is laid on and a detachable water bowl is provided for every pair of animals. The total cost of the iron work including all pipes, bends and fittings, name plates and manger divisions, was £45, for ten animals. The building was erected by Mr. Watts, the College Engineer. The byre has been a complete success. The oxen surprisingly soon learned their own stalls and are fastened without any difficulty. They appear to be quite comfortable even without litter, and no trouble is experienced.

The illustrations give a clear idea of the general arrangement of the byre, which it may be mentioned, is lit with a couple of electric lights for the purpose of keeping away bats at night.

The cost of the various buildings mentioned above is as follows:

Main Building, Implement Shed and Engine House, &c.	£1,700
Threshing Floor	90
Cattle Byre	200
Drying Floors	130
New Implement Shed	60

The writer will be pleased to give any further information to anyone interested.

R. C. W.

WEST INDIAN NOTES.

COMPILED BY THE COMMISSIONER OF AGRICULTURE,

College Advisory Department.

Cotton.

THE planting season has opened in Antigua, Nevis, St. Vincent and Barbados. In Antigua where cotton growing had, to a very large extent been given up, some 1,500 acres have been planted. In Nevis the area will be about the same as last year, 2,500 acres. In St. Vincent the area will probably approximate the maximum planting of a few years ago and in Barbados it is reported that some 2,500 acres are being planted under cotton this season. In spite of the low prices and the sluggish market for cotton, the output in these small islands has tended to increase as the product is non-perishable. Cotton also seems to be the only crop which will, to some extent, take the place of sugar-cane and provide work for a few labourers. The change of the planting season in St. Vincent gave such good results that the cotton growers after a considerable reduction in area in the 1929-30 crop season, have regained their confidence and increased the area.

The Cotton Research Officer, Mr. S. H. Evelyn, whose cotton breeding work is being directed by Dr. Harland, has laid out an ambitious programme of work and confidence is felt generally amongst the cotton growers of St. Vincent that the local cottons will very shortly be restored to their original condition of purity of seed. Dr. Harland recently paid a visit to Montserrat. His report shows that while there has been some contamination and hybridization in the cotton fields in certain districts, the Montserrat cotton is pure at its source, and that the seed distributed by the Agricultural Department is pure line pedigree seed. The report also indicates that there is an ample supply of good seed available for the coming season's planting, and steps have now been taken to provide Government control for its distribution. The Ordinance which is now under consideration will prohibit the planting, or distribution for planting, of all cotton seed which has not been inspected and approved by the local Department of Agriculture. A Proclamation has just been issued by the Montserrat Government which fixes the close season of cotton between 31st December and 22nd February next.

During the past two seasons little damage has been done to cotton by insect pests. The pink bollworm has been conspicuously absent from fields during the growth up to the first picking of the cotton and in Montserrat last year an attempt was made, with some success apparently, to reap a second crop. Stainers in St. Vincent have not been abundant and attacks of the cotton caterpillar have not been serious in any of the islands. Recent experience emphasises the belief that so long as efficient cleaning up work is carried out at the end of the cotton season, both pink bollworm and stainers will be controlled properly and that the prevalence of these insects will be related to the development of the crop rather than to a definite period in the calendar year.

Fruit and Vegetable Trade.

The fruit and vegetable industry in the West Indies continues to develop. From Montserrat in the 1929-30 season some 4,500 crates of tomatoes were shipped, mostly to the Canadian market. In the coming season it is expected that the shipments will be much larger. The new packing shed is completed and the Agricultural Department will be better able to deal with the increased bulk of fruit which it is expected will come forward for shipment. Plans for a pre-cooling and storage plant are under consideration. St. Kitts expects to ship tomatoes this season on a considerable scale also, and a packing shed has been erected.

Representatives of the Canadian West Indian Produce Co. recently visited the West Indies and completed arrangements with the growers in Montserrat and St.Kitts to take all the tomatoes shipped from those two islands on the basis of an f.o.b. price plus an equal share in all profits over and above the purchase price. The price to be paid at Montserrat is five and a half cents per lb. and at St. Kitts five cents. The higher price is being paid at Montserrat because the buyers have seen the good quality of the fruit shipped from that island in the past two years. St. Kitts' tomatoes will be shipped in quantity this season for the first time. The Agricultural Department, Antigua, carried out preliminary experiments in the 1929-30 season in tomato growing. These experiments served to show many of the difficulties that will have to be met, but it is expected that several trial areas will be planted with tomatoes in the present season on estates and by peasant growers.

In Dominica the damage caused by the September storm to the packing house has been repaired and the equipment of machinery and apparatus has been installed. The shipment of citrus, mangoes, and other fruits, will continue on a larger scale than in the past. The death of the Honourable J. Colin Macintyre has been a serious loss to the fruit and vegetable trade and the peasant advisory bureau. The successor to Mr. Macintyre has not yet been appointed. The work is being carried on by members of the staff of the Dominica Agricultural Department.

In St. Lucia a fruit exportation Ordinance has been passed following closely on the provisions of the Dominica Ordinance. In St. Lucia and St. Vincent it is expected that trials of various fruits will continue to be made and that some increase in this trade will be shown during the coming season. In Grenada a new packing house has been prepared.

The development of the fruit and vegetable trade and the schemes for Land Settlement will increase the work of the several Agricultural Departments and make it necessary for additional officers to be appointed. In Dominica the Government has acquired Copt Hall Estate where the nursery work that was started there will be continued. This estate will be developed as a demonstration farm and it is also hoped that a Land Settlement scheme may eventually be established there.

Java Seedlings.

During the last two or three years much interest has been shown throughout the West Indies in certain P.O.J. sugar-cane seedlings and planting material of some of these canes has been introduced where any interest is being taken in sugar-cane cultivation. This planting material has been received from different sources and in varying quantities, usually only a few cuttings being introduced at a time. Had it been available, more would undoubtedly have been introduced. It is wise, however, to restrict the introduction of such material which should come from localities where no sugar-cane diseases of special importance are known to exist, and, if possible, from sources where it has been under observation for the possible development of pests and diseases.

There are several sugar-cane diseases in the Dutch East Indies and some of them which are very important, have not yet been recorded in the American Tropics. To mention only one of these, reference may be made to *Pokkah Boeng* which is caused by the fungus *Fusarium moniliforme*, *pokkah boeng*, meaning "damaged top." The tops of sugar-cane often are damaged or injured but this name is being definitely applied to the condition resulting from the development of the fungus. The damage may range "from the stunting of the leaves to a complete matting and tangling of the entire top; in ultimate stages of heavy infection the tops are dead and rotted. The first symptoms are seen in the presence of irregularly shaped yellow chlorotic areas at the base of the young leaves, the upper part of the leaves appearing quite normal. Reddish brown streaks and patches of dead tissues soon appear and they may remain of small size or may gradually extend over the greater part of the yellow portion of the leaf. As a result of this great weakening of the tissue, the leaves frequently break at this point and hang limply down the stalk." Later in the season the infection may extend into the cane stalk where it may be seen in the form of fine brownish streaks and a series of cavities that present, on sectioning, a characteristic ladder-like or chain-like appearance which serves as a diagnostic symptom of the disease. Suspected canes should be cut longitudinally in very thin sections or this ladder-like appearance may be missed.

This disease is confined mainly to varieties P.O.J. 2878 and P.O.J. 2722. So far it has been only reported in Java and has not been known to be transmitted through planting material. There is no known cure.* Careful observation should be maintained on all introduced P.O.J. varieties, particularly P.O.J. 2878, in order that the first appearance of the disease may be immediately notified.

Land Settlements.

The value of Land Settlement schemes for establishing the peasantry on the land with provision for ultimate purchase and ownership is being recognised in several of the West Indian islands at the present time and schemes are under consideration and being developed in Antigua, St. Kitts-Nevis and St. Lucia.

The Land Settlement project which was developed in St. Vincent after the visit of the Royal Commission to the West Indies in 1897 has been eminently successful. No development has taken place since that time in these islands on a scale comparable to that of St. Vincent.

In Antigua the scheme has gone so far that rules and regulations are being formulated. A survey is being carried out and a portion of the land being acquired under the general scheme is being laid out as an Agricultural Experiment Station. The Antigua Experiment Station at Skerretts has long been known to be very unsatisfactory. No other site has been available, however, and the location within easy reach of the Botanic Gardens and headquarters of the Agricultural Department rendered supervision fairly simple. Skerretts, in spite of its unsuitable soil which is not typical of any agricultural soil in the island has been utilised year after year. A change to a new site will be welcomed by all who are interested in the agriculture of the island. In St. Kitts-Nevis and in St. Lucia, consideration is being given to plans and projects from which material developments should be made shortly.

Miscellaneous Information.

Mr. G. A. Jones, the Assistant Commissioner, who has been on tour in the Leeward Islands, has visited Antigua, St. Kitts-Nevis, Montserrat and Tortola. The agricultural conditions in Tortola are in great need of improvement and Mr. Jones' Report on this visit will be awaited with interest. At Antigua and St. Kitts-Nevis the Assistant Commissioner was in consultation with the Governor in connection with Land Settlement schemes. In Montserrat he was associated with Dr. Harland in the investigation of the cotton situation, and consulted with the local Government Committee appointed to consider the purchase of Grove Experiment Station and additional land for the use of the Agricultural Department. Mr. Jones will also

*Bulletin No. 2, Division of Pathology, Bureau of Sugar Experiment Stations, Queensland, 1929.

visit Dominica and is expected to be present in St. Lucia to attend the Conference which is being called by the Governor of the Windward Islands for the discussion of the marketing of fruits and vegetables from the Windward and Leeward Islands. Representatives to this Conference will include the Commissioner of Agriculture and administrative and agricultural officers from St. Lucia, Dominica, St. Vincent and Grenada.

* * *

In accordance with the scheme put forward by the Secretary of State for the re-organization and regrading of Agricultural Departments in the Windward and Leeward Islands, the office of Superintendent of Agriculture for the Leeward Islands has been abolished and the Honourable A. E. Collens, who for several years has carried on the combined duties of Government Chemist and Superintendent of Agriculture, now relinquishes his duties as Superintendent of Agriculture and will in future be able to devote his whole time to the duties devolving on the Government Analytical Chemist. Mr. F. H. S. Warneford, who has been Assistant Government Chemist, has been appointed Agricultural Superintendent, Antigua.

* * *

An attempt is being made to improve agricultural conditions in the small island of Anguilla, and provisions have been made for the appointment of an Agricultural Instructor. Agriculture in Anguilla is almost entirely in the hands of the peasantry, which, in the past has been successful in growing Sea Island Cotton, an industry which, it is hoped to stabilize. Minor crops may also be developed.

* * *

The Black-headed Persian sheep which were bought by the Trinidad Department of Agriculture have now arrived in Trinidad. The sheep, 81 in number were, with one exception, in good condition. Rough weather was experienced during the voyage, and three of the animals were injured by trampling. Two of these died and one was landed in a feeble condition. These sheep are mostly intended for Trinidad, but a few are going to other islands. Orders for Montserrat and St. Vincent were received in Trinidad too late to be included in the present shipment.

* * *

The resistance of limes and other citrus grown on sour-orange stock to the violent winds in the recent hurricane in Dominica is so important as to justify the repetition of the advice to plant only budded material in the hurricane area. Also, as the sour orange is resistant, if not immune, to red root disease, budded stocks should be planted in all localities where this disease is known or is likely to occur.

* * *

In all the Leeward and Windward Islands, the past year has been one of drought and reduced rainfall. In Antigua, St. Kitts and parts of Barbados, the sugar-cane crop is reported to have suffered very seriously from the lack of moisture, and considerably reduced crops are estimated for the coming season. The year 1930 has been a season of unusual weather. The rainfall has been generally deficient and sugar-cane, cotton and all other crops have been more or less affected by the continual drought. Sugar-cane has perhaps suffered most and in parts of Antigua, St. Kitts and Barbados, cane fields are very backward, and in some the canes are practically dead.

H. A. B.

THE EDIBLE CANNA.

Edible Canna (*Canna edulis* Ker) is not very exacting in its climatic requirements. Although the plant is perennial and is best suited to tropical countries, it can be grown in most areas which have a frost-free season sufficiently long to bring the tuber to maturity. Like all root crops, the edible canna does well on a fertile sandy soil, but even better on a rich sandy loam well supplied with humus. It will also grow on heavier soils but these render the work of harvesting difficult. The crop can be utilized as a commercial source of starch. It is a good staple field crop which can be grown throughout the year and readily converted into cash. The Queensland or Australian Arrowroot is Edible Canna starch. The possibilities of the Waimea district of Hawaii as a canna-producing region have led to experiments with the root as a source of commercial starch. Results of field experiments indicate the desirability of selection. Under Waimea conditions tubers should be planted at least four inches deep and at distances of four by four feet. For starch manufacture the crop should be harvested at 17 to 18 months. The average composition of Edible Canna tubers is: water 72.62 per cent., protein 0.98, fat 0.11, nitrogen free extract 24.28, crude fibre 0.61 and ash 1.40. Analysis of the different parts of the canna plant shows that the tops are of value both as feed and as fertilizer.

In Rhodesia it seems likely to have a great future as a valuable succulent feed for all classes of stock. The feeding value of both the tubers and tops compares favourably with that of other starch and forage crops. It makes quick growth and produces heavy yields of both tops and tubers. The tubers have excellent keeping qualities and can be left in the ground and harvested when required, or can be lifted and stored. Plants resist drought well and will also withstand a very wet season when grown on well drained soil.

The crop can take the same place in a rotation as the ordinary potato or sweet potato. It is not advisable to grow canna on the same land year after year, as it is a heavy feeder and robs the soil of much organic matter. (*International Review of Agriculture*. Year XIX. No. 12.)

A COFFEE BEAN DISEASE.

A Parasitic Disease of Coffee Beans.

By G. B. WALLACE, B.Sc., Ph.D.
Mycologist, Tanganyika Territory.

[*The following article is a sequel to a note on the discovery of a parasitic disease of coffee beans which was published in "Tropical Agriculture," Vol. VII, No. 5 (May, 1930), p. 141. Although much still remains to be learned about the disease sufficient data has now been collected to discuss its economic importance and means for its control.*]

The Disease.

It cannot be said with certainty how long this disease of coffee beans has been known, since it is easily confused with what is apparently a non-parasitic trouble; the latter is described below under "Coffee Cherry Fall." The solution to the cause of the disease under discussion was indicated when spores of a *Nematospora* species were found in shrivelled coffee beans in December, 1929.

A certain amount of infection has been found in small green coffee cherries one-eighth inch long, the proportion of affected cherries increasing throughout the season. One plantation was observed where, at the very end of the season, December, tons of cherries had been left unpicked, on account of the black shrunken beans inside. Three hundred such berries were examined: of these 295 contained one or more beans affected by *Nematospora*. On this plantation, it had been estimated by local coffee planters that a crop of 300 tons would be obtained, whereas the yield proved to be but 28 tons. This loss of some 90 per cent. of the expected crop was certainly due very largely to destruction by the fungus.

A notable feature in this, and other, stigmatomycosis diseases is that the fruit appears healthy externally, and grows practically to normal size. The only external indication that the beans may be diseased is the occurrence of tiny punctures on the skin, caused by the mouthparts of bugs. In sections of the cherry, these punctures show as fine dark lines extending to the underlying bean. The bug, in piercing the bean, introduces the spores of the fungus. The parchment round the bean shows one or more dark spots, where it has been punctured, but is not further affected. The bean itself is also spotted, and is discoloured within.

The fungus grows at the expense of the bean, and in old infections the bean is shrunken, and little more than a dry shrivelled skin remains; the effect is a dry rot. Disease in the bean of one locule appears not to spread to the bean in another; one is frequently affected and another sound. Such diseased cherries are one important cause of light coffee or floats after pulping.

The Cause of the Disease.

The *Nematospora* fungus found associated with this coffee disease has been isolated in culture from both young and old cherries. It has been identified by Mr. W. Nowell and by Mr. S. F. Ashby as *Nematospora Coryli* Peglion. This organism is one of the parasitic yeast fungi, and was first described from hazel nuts in Italy [12, 13]. Ashby's identification of the species on coffee was made from a culture isolated at Amani, on potato mush agar, with spore measurements 26 to 37 × 2 to 3 microns. Measurements in a culture, made by the author at Moshi were: asci 52 to 93 × 4 to 6.3 microns; ascospores 30 to 39 x 1 micron. These measurements, with the one exception of spore width in the Moshi material agree closely with those recorded by Peglion [12, 13], Ashby and Nowell [1], and Wingard [19], on hazel, cotton, and lima bean respectively. The width of the spore is given by these authors as 2 to 3, 2 to 3, and 2.5 to 3 microns respectively; the width of the spores in the present author's material—from diseased coffee beans and cultures on oat agar—is without exception one micron. Yeast cells in the Moshi coffee material measure up to 6 × 3 microns; Nowell gives 6 to 12 microns for the diameter of yeast cells of *N. Coryli* from cotton. Yeast cells occur less frequently in the Moshi coffee *Nematospora* than is usually recorded to occur in *N. Coryli*. In spite of these small differences the species isolated at Moshi is believed to agree sufficiently closely with the form isolated at Amani and identified as *N. Coryli*.

This organism is known to cause considerable loss in the seeds and fruits of a variety of other plants, for example cotton [1, 5, 6, 7], many legumes [1, 19, 20], citrus [4, 10], and others [1].

With regard to earlier work on disease in coffee cherries, the following should be recalled. In 1903, Zimmermann recorded [21] brown coffee beans associated with bug punctures in this country (formerly German East Africa). No fungus was detected, and it is possible that he was associating with the bug punctures the disease described below as Coffee Cherry Fall, which is probably due directly to physiological causes. Zimmermann recorded [22] the insect associated with the brown beans as *Antestia variegatus* Thumb. var. *lineaticollis* Stal. Morstatt in 1912 quoted [9] Zimmermann's observations. In 1929, Ritchie [14], referring to this bug under the more usual name *Antestia lineaticollis* Stal., suggested that it might be transmitting a parasite organism. This is now proved.

In 1921, Small recorded [15] that he found in Uganda *Antestia orbitalis* Westw. var. *faceta* Germ. (*A. lineaticollis* Stal.) to be carrying spores of a *Phoma* sp., which he found on coffee branches and on broken cotyledons in the condition known as 'broken beans.' In 1921, he stated [16] that cultures from the legs and beaks of Antestia yielded only Phoma. He considered that the bug was responsible for the presence of the fungus in tissues which the latter might be otherwise incapable of penetrating.

Butler in 1918 described [8] the entry of common moulds through the punctures made by a sucking insect, *Poecilocoris latus* in tea fruit, the seeds of which were frequently reduced to a shrivelled mass. He suggested that the bug *Bagrada picta* might be responsible for a similar disease in coffee. This latter bug is known in Kenya; *B. hilaris* Burm. occurs in Tanganyika, and is another possible vector, as it is widespread and occurs in fair numbers on coffee trees in certain areas.

Distribution.

Stigmatomycosis has now been found in all the important coffee areas in Tanganyika Territory, being first recognised in plantations on Kilimanjaro in December, 1929. In June, 1930, the author was informed by Hansford that he had sought and found *N. Coryli* in diseased cherries in Toro, and that it is probably present in most of the Uganda coffee areas. Further investigation will, without doubt, indicate a comparatively wide distribution throughout East African coffee districts. The bug *A. lineaticollis*, which transmits the disease, has been stated by Wilkinson [18] to occur in most countries between Uganda and Cape Colony. This author mentions *A. cruciata* to have been recorded by Bainbrigge-Fletcher as an occasionally serious pest of coffee in India. Other bugs which may act as transmitting agents have been mentioned above. Green bugs of the genus Nezara are widespread pests on many plants and may be capable of spreading the disease.

As a parasite of other crops, *N. Coryli* has a wide distribution, having been recorded in Europe, America, Asia, and Africa; it would, therefore, not be a matter of surprise to learn of its more general occurrence in coffee.

An Experiment with Antestia.

The bug *Antestia lineaticollis* has been found invariably associated with the coffee bean disease in plantations visited. In four plantations, where the disease was apparently absent, the bug could not be found. These were in a new coffee district, in which the bug had not become widely established.

To test the hypothesis that the Antestia might be the vector in the dissemination of *Nematospora* spores or yeast cells in coffee, an experiment was carried out in the field. A plantation was fortunately at hand, in which neither the Antestia bug, nor diseased beans could be found during several hours search on a few days.

Just prior to the experiment, 300 cherries were carefully examined, some microscopically; these were found all healthy. Antestia bugs were taken from a highly infected plantation; these were placed, one in each of four muslin bags, which were then placed over coffee twigs, from which the majority of cherries were stripped (and incidentally found clean). Forty-four days later a further 300 cherries, not enclosed by bags, revealed on examination, partly microscopic, not one diseased bean. With regard to the four twigs subject to Antestia punctures, all the cherries were examined microscopically, with the following results:

Twigs, each with one coffee bug.	Total cherries.	Cherries with diseased beans.
I	5	4
II	9	7
III	7	7
IV	8	0
Control:		
No. coffee bugs ..	300	0

On the first three twigs, the majority of cherries were found diseased after this contact with Antestia; *Nematospora* spores were found in each diseased bean. The bug on twig IV had apparently been clean: the cherries with which it had been enclosed showed punctures, but the beans revealed only small marks on their surfaces, and contained no spores.

It is still desirable to obtain clean mature Antestia from the egg-stage, and to infect them from a culture of the fungus, for use in experiment. Results obtained, however, are sufficiently indicative that Antestia carries the spores of the fungus from one cherry to another. A spore suspension in water, which was sprayed on to healthy unpunctured cherries under gauze and kept moist, did not give rise to any infection. Also, spores injected by a hypodermic syringe did not develop, probably owing to heavy infection by bacteria, consequent on the lack of precautions against contamination.

Control.

There is no possibility of spray fluids reaching the fungus, since the latter is located within the seed. On the other hand, the extent of control will be largely governed by the thoroughness with which the insect vector, Antestia, is itself controlled.

Control of Antestia:—The following is briefly the method recommended by Ritchie [14] in Tanganyika Territory. It has proved very effective, and is at the same time rapid, economical, and, with care, safe.

One half pound of sugar is dissolved in water; 20 grammes of sodium arsenite are dissolved in some warm water. These two solutions are added to water to give four gallons of spray mixture. This is sprayed in minute drops over the foliage; one, or at most two, flicks from the sprayer suffice for each bush, more than that will cause scorching. The spray is applied once every ten days, and oftener if it is washed off by rain. Note: the arsenite of soda in this spray is a most dangerous poison.

It may be stated with significance that on a coffee plantation, where Antestia had been numerous, and where the arsenical bait was being applied five times throughout the season, a very healthy crop was produced. When examined at the end of the season, neither Antestia nor diseased beans could be found. Other methods for control of Antestia are given by Wilkinson.[18]

Attention must also be drawn to other possible methods of control of the disease. The source of infection to young cherries can be largely eliminated by removing from the trees all red fruit which remain at the end of the season. This should be immediately followed by an application of the sweetened arsenic spray. If this is done early, before blossoming starts, the number of infected bugs will be largely reduced, and the coming flush of young green fruit will have a considerably greater chance to remain clean. Ripe cherries should not remain on the trees longer than is absolutely necessary.

With regard to the possibility of infection of coffee from other hosts of the fungus, this will depend on whether bugs migrate from such hosts and feed on the coffee cherries. Until definite information on this point is forthcoming, other crop plants, which are hosts of this fungus, should be grown at some distance from coffee. Leguminous cover crops, some of which are known hosts of the fungus in coffee beans, must be regarded with suspicion meantime; it may prove necessary to cut them down before they set pods, but information is first required on their significance as a source of infection to coffee.

Coffee Cherry Fall.

Another disease is common in the coffee plantations of Northern Tanganyika. No *Nematospora* nor any other fungus has been found in association, nor isolated by culture methods. The presence of this trouble complicates the recognition of the parasitic bean disease in the field.

This disease, as evidenced by its most striking feature, the amount of cherry fall, is most acute in the early part of the year, and observation so far associates the trouble with the end of the rainy season. It appears to be distinct from the cherry fall caused by thrips.

While there is need for further observations on this disease, it may be stated that the indications are that it is due to physiological causes, and that like twig die-back, and susceptibility to leaf diseases, it is an expression of lack of sufficient vigour in the trees, in this case, to carry to maturity the amount of cherries which set.

This trouble recalls the disease described in South India as 'Jollu' or 'Black Bean.' There, healthy branches are stated by Thomas[17] to bear cherries "which though sound to all external appearances are spotted or stained within." Also, "In its worst form the meat is stained and shrivels up in drying, or the whole contents of the berry become rotten with the formation of a brown liquid." No pathogenic organism has been observed. It was noticed, according to the author, however, that the damage in a sprayed area was less than half the loss sustained in the control plots. This may possibly be accounted for by increased vigour in the trees, consequent on reduction of disease for which the spray was applied. Munro[11] considers this disease to be bacterial; he mentions also that it seems to occur only under conditions of high humidity and rain, and that with the cessation of these the spread of the disease in the bean seems to cease. In appearance, and in effect, the Indian 'Black Bean' disease appears to resemble closely the condition recognised as Cherry Fall in Tanganyika. In any case, the latter name is preferable for the trouble in this country, since while it indicates one of the chief features of the disease, it distinguishes this trouble from the parasitic bean disease, in which fall of cherries is not a recognised feature.

To facilitate the distinction of the two bean diseases, as they occur in Tanganyika, the following table is given :—

Nematospora Coffee Bean Disease or Stigmatomycosis.	*Coffee Cherry Fall Disease.*
(1) The disease occurs in all flushes of fruit.	(1) One flush of fruit may be more affected than another.
(2) Falling of the fruit is not a feature.	(2) Heavy fall of fruit is the chief character calling attention to the presence of the disease.
(3) The disease starts at the point where a bean is punctured by a bug.	(3) The disease starts from the base of a cherry, or from the base of a cherry stalk bearing one or more cherries.
(4) The cherry pulp is not affected.	(4) The disease spreads upwards, gradually discolouring the entire cherry.
(5) Only one bean in a fruit may be affected.	(5) All the beans in a fruit are equally affected.
(6) The cherry stalk is not affected.	(6) Part of the cherry stalk becomes pulpy or mealy in appearance.
(7) The bean becomes dry, as it darkens and rots.	(7) The bean remains moist, or becomes quite wet, as it darkens and rots.
(8) Diseased beans invariably contain spores of *Nematospora*.	(8) There are no organisms in the cherry, until it decays.

Other diseases have been recorded in coffee cherries. McDonald has described[8] from Kenya Colony a 'Black Berry' or 'Coffee Berry Disease,' due to a form of the fungus *Colletotrichum coffeanum* Noack. In Brazil, Averna-Saccá described[2] in 1925 a condition in coffee cherries, which he refers to as Cafe Choco. Coffee trees bore cherries which were roughened, blackened and sometimes decayed, and which tended to fall prematurely. He attributes the damage to a number of fungi; he names five of these, and states that they attack the cherry during ripening.

Summary.

In December, 1929, *Nematospora Coryli* Peglion was found to account for much of the disease in coffee beans in Tanganyika Territory.

This 'stigmatomycosis,' disease occurs also in Uganda; it will probably be found to have a much wider distribution.

The Coffee Bug, *Antestia lineaticollis*. Stal., carries the spores from one coffee cherry to another.

Control of the disease can be effected by the use of sweetened arsenite of soda to destroy the bug, and by removing diseased coffee cherries from the trees. The possible significance of other hosts of the fungus is referred to.

A physiological disease, 'Coffee Cherry Fall' is described, and distinguished from the parasitic disease. It resembles some diseases of coffee cherries, recorded by others.

Other coffee cherry diseases are referred to.

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COTTON IN TANGANYIKA.

THE methods adopted in the Tanganyika Territory to foster the cotton industry, and the progress that has been achieved, provide an interesting study, for conditions in this country are somewhat different from those obtaining in most other Colonies, in that the Agricultural Department has had to build on a foundation laid during German rule. Although it is no doubt true that the four years of war, during which three armies were practically supported by the country, have brought about the disappearance of most of these foundations, yet some have remained and have formed both a help and a hindrance to the present administration. Mr. Kirby, who came as the first British Director of Agriculture in 1921, and has only recently handed over the charge to his successor, describes this progress in an article in the *Empire Cotton Growing Review*.*

The methods adopted under German rule appear to have savoured somewhat of compulsion. It is a common practice of British administration to prohibit the cultivation of certain crops, notably dangerous drugs, or to permit them only under license, but we do not at present compel the peasant to plant any particular crop, though this was part of the German policy of cotton production. It may, in passing, be remarked that such a practice is considered justifiable by other Tropical Administrations, and no doubt has in the past been adopted by ourselves.—(*Bull. Ag. Congo Belge*, XX, 449.)

Another interesting feature of German days was the optimism felt with regard to the capitalistic production of cotton, which led to the formation of a number of large companies, growing cotton under plantation conditions. Many of these worked on a considerable scale, depending on steam tackle, as well as on native labour, for their cultivation, a policy which Mr. Kirby states, led them in some cases to break up unsuitable heavy soils of the high grasslands and savannahs, which from their flatness and freedom from tree growth, appeared to offer conditions, in other respects, conducive to success. In spite of this the production by Europeans never amounted to more than a third of the total; the proportion to-day is about a quarter, and is rather surprisingly high. One lesson had been well learnt which saved the time and money of the new Department, that only Upland cotton of the Nyasaland type was likely to be successful, and that the experience the Germans had had with Egyptian types and with Caravonica was definite. Egyptian cotton was at first the kind mostly sown, but suffered severely from pests and diseases of all kinds.

With such a start, the late Director describes what has been done, and shows clearly the increase in production that has taken place in the last eight years, with one exception in 1927, which

* The Progress of Cotton Growing in the Tanganyika Territory. A. H. Kirkby—*Empire Cotton Growing Review*, Vol. VII, 169.

delayed, but did not reduce, the steady rate of about 4,000 bales a year, at which production is rising. Mr. Kirby goes on to indicate the various conditions which in his opinion, affect the problem, and his observations are worth digesting by every Agricultural Officer, for they embody considerable experience of both coasts of Africa. The native peasant is the most important factor; tribes differ considerably and progress will be more rapid with a good type, one that is alert, industrious and desirous of the luxuries which his cotton will enable him to purchase. Nor must he have other outlets for his energy, in the shape of plantation industries, for where a policy of non-interference with the native is consistently followed, he will be tempted to choose the good wages which he can get by working as a paid hand, rather than the less certain return he may get from growing cotton on his own. It is noticeable too, that in the neighbourhood of the large towns, where there is a steady demand for food crops, grains or groundnuts are preferred: they bring in nearly as good a return as cotton, and are more dependable. Lack of economic transport is unfortunately only too often a limiting factor in growing cotton in this Territory, though conditions in this respect are being steadily improved.

The policy of the Department has been, briefly, to remind the peasant each year of the advantages of the crop and the precautions he must take in cultivating it to supply him with good seed, and in the end to provide him with fair marketing facilities. He is encouraged to regard cotton as one of the ordinary crops of the country to be grown in rotation with them and to be accorded similar treatment to that which they receive. Along these lines progress may not be so rapid as by the adoption of what may be termed more direct methods, but they are sound and less likely to suffer a set back from a temporary drop in prices.

R. C. W.

THE POTATO TUBER-MOTH.

The recent arrival at Port-of-Spain from New York of a consignment of potatoes infested by an insect, believed to be the Potato Tuber Moth which is known as a serious pest of potatoes and tobacco, may be taken as an instance of the danger in such imports and the need for their careful inspection on arrival.

The Potato Tuber Moth has long been well known as a serious pest in Mediterranean countries, Australia and New Zealand. In 1891, it appeared in California. The insect is now recorded from these localities and many others. The insect is *Phthorimaea operculella* Zeller. In the more temperate portions of its range it is a pest of potatoes, and in other places it attacks tobacco, tomato, and eggplant. Its native food plants are believed to be Solanaceous weeds. It is recorded as occurring in the following localities:—Australia, New Zealand, South Africa, Rhodesia, Egypt, Algeria, Morocco, Canary Islands, The Azores, India, Java, Brazil, Chili, Canal Zone, Haiti, San Domingo, Mexico, Hawaii, California, Texas, North Carolina and other Southern States as far north as Colorado, Virginia, and Maryland. It has been intercepted in potatoes at American ports from England, France, and Spain.

As a pest of potatoes it is most serious when the attack reaches the tubers. The eggs of the first generation in the season are laid on the leaves, the larvae live on the leaves or as leaf miners under the epidermis, and as stem borers and pupae are found in sheltered places on the plant or in the ground. In later generations the larvae attack the developing tubers feeding at first just under the epidermis or skin of the potato, penetrating deeper as the attack progresses. Potatoes that are exposed when growing in the field, and even when lying on the ground after digging may be attacked.

Breeding continues in stored potatoes and perhaps the greatest losses occur from the continued attacks in stored potatoes. Potatoes which show no signs or very little signs at the time of harvest may be completely destroyed while in storage. It is recorded that in Australia and in Algeria, as much as one-half to two-thirds of the crops have been sometimes destroyed by this pest. In its attack on other plants this insect is known as a miner in the leaves and stems except for rare attacks on the fruit of the tomato. As a pest of tobacco it is known as the tobacco splitworm. It splits the leaf by its mines beneath the epidermis. As borers in the stems of the potato plant the caterpillars often cause the plant to wilt and die.

The continued breeding in potatoes after they have been dug and stored makes this a dangerous insect in imported potatoes. While it is not believed that this insect will live and breed very far to the North, cold weather and moderately low temperatures probably affect it only to the extent of retarding its development. The records of interceptions of the Potato Tuber Moth in potatoes from England, for instance, may be in connection with potatoes imported to that country and re-exported.

The Potato Tuber Moth has probably been introduced to new localities with imports of potatoes either for planting or for consumption as food.

The attack of this insect on the so-called English or Irish potato (*Solanum tuberosum*) produces an effect similar to that resulting from the attacks of the sweet potato weevils (*Cylas formicarius* and *Euscypes batatae*) on the roots of the sweet potato.

Potatoes that are badly attacked are not fit for human consumption. Potatoes that are attacked even slightly may be the means of introducing the moth into localities where it does not occur, and as it is one of those insects which it is practically impossible to control, every practical means should be taken to prevent its introduction into countries at present free.

H. A. B.

CO-OPERATIVE CREDIT.

Mauritius Report for 1928-1929.

THE Administrative Reports of the Colony of Mauritius (Port Louis, 1930) contain a summary of the activities of the Co-operative Societies for the year ended 30th June, 1929. Although the Societies are passing through a difficult phase, the Registrar is of the opinion that scope exists for the extension of the movement. There exist 26 active Societies with a rather high average membership of 93. Two-thirds of the members contracted loans during the year, which averaged Rs. 169. Some 805 members are in arrears in repaying loans, the outstanding aggregate being Rs. 131,395, part of which dates back to 1919-20, though the majority—Rs. 80,042—became overdue in 1926-27 and 1927-28.

The amount overdue from 1920-21 to 1922-23 is unusually low, but this may be due to fictitious renewals. These arrears are attributed in large measure to administrative slackness, viz.: the willingness of Committees to continue accepting vague promises of repayment, and their reluctance to have recourse to the Courts, the lack of adequate preliminary inquiry as to the possibility of repayment or the economic soundness of the proposition, and the acceptance of loans from other sources which insist more rigidly on repayment. An extremely important factor is to be found in the particularly sharp fall in the prices of the staple products of the island and the general financial depression which has prevailed. An interesting feature is the limited extent to which the Societies rely upon external sources for capital. Most of the Societies have, in fact, rendered themselves entirely independent of borrowed capital, and still are able to meet the requirements of their shareholders.

Principal Sources of Capital.

Year.	*Share Capital.*		*Deposits of Non-Members. Rs.*	*Deposits of Members. Rs.*	*Government Loans. Rs.*	*Reserve Fund. Rs.*
	A Shares Rs.	*B Shares Rs.*				
1927-28	89,924	3,340	3,590	1,822	7,060	171,743
1928-29	85,296	3,304	3,050	822	5,220	185,272

The situation is similar to, but rather more favourable than, co-operative movements in other Crown Colonies. To stop the excessive liberality in granting loans a "Register showing the borrowing power of every member of a Co-operative Society" was introduced. This is a very important and desirable step. The experience of Mauritius and elsewhere indicates that for such Societies to be successful :—

(i) They must meet the full and legitimate credit requirements of the members.

(ii) Loans should be granted solely for sound and reasonable economic purposes.

(iii) The soundness of the proposition should be investigated by responsible members of the Society who should also see that the loan is properly applied.

(iv) The loan must be adequate both in respect of amount and time.

(v) Repayment should be rigidly insisted upon except when good reasons for non-repayment are advanced to, and accepted by, the Society.

(vi) The Society should seek to improve the general standard of agriculture of its members by methods such as insisting upon the adoption of good cultural practices by borrowers, arranging meetings on the holdings of various members, and co-operation with the Department of Agriculture.

(vii) The Society should also enable provision to be made for the other economic requirements of the members, otherwise it remains merely a cumbersome and expensive method of advancing money. In other words, there must be real co-operation.

(viii) The members must consist of a limited number of industrious and honest individuals drawn together by feelings of mutual trust and economic interests.

(ix) The Societies should be advised and guided, particularly in their early stages of development, by a trained and experienced officer. Few peasants appreciate the principles of co-operation or the method by which such Societies should be organised and managed, and the absence of sympathetic and competent advisers has been responsible for many failures which could have been avoided.

Enthusiasm is part of the essential equipment of every co-operative worker but unless it is supported by a co-operative knowledge, acquired preferably by training and experience, is apt to be extremely dangerous.

C. Y. S.

SOUTH AMERICAN CATTLE.

IN South America to-day three methods of cattle breeding are employed: (*i*) Crosses of native Criollo breeds with beef breeds such as Shorthorn, Aberdeen Angus, Hereford, in order to achieve early maturity and increased beef production. (*ii*) The dairy industry prevails in Southern Chile and Argentine, the breed preferred being the Black Pied Lowland cattle. In the thinly populated middle region, breeding is directed towards resistance against climatic influences and certain diseases, since the animals have to suffer heat, lack of food, drought, and Texas fever. For this purpose, out-crossing to the Zebus, which are resistant to these harmful influences, is practised; the cross-bred animals are poor beef producers, but good for draught, riding, and carrying loads.—(*Imp. Bur. of Animal Genetics. Quarterly Bulletin*, No. 3.)

TROPICAL WORLD NOTES.

British Guiana.

According to Colonial Report (No. 1496) the total value of domestic produce showed a decrease of 17.5 per cent. for 1929, the main item responsible for this drop being sugar which showed a decrease of £454,350. The sugar crop was 117,254 tons as compared with 100,414 tons, the average for the preceding ten years, the area reaped 56,126 acres, and the average yield of sugar 2.09 tons per acre. There were 63,441 acres under rice, of which 10,452 acres yielded both spring and autumn crops. The total yield of padi was 72,096 tons, equivalent to about 43,257 tons of cleaned rice. 14,091 tons of rice were exported in 1929 as compared with 18,083 tons in 1928. There were 28,000 acres of land under coconuts, exports of nuts amounting to 637,812. In addition 75,187 cwt. of copra and 20,862 gallons of coconut oil were exported. A great number of the nuts gathered were used locally for the manufacture of copra, coconut oil, or directly as food. There is a very wide area of lighter soils on the front coastlands suitable for planting with coconuts. There were 5,905 acres under coffee, and exports amounted to 8,098 cwt., as compared with 8,212 cwt. in 1928. The area is capable of considerable expansion, notably in the North-West and Pomeroon Districts.

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Basutoland.

The Agricultural Department according to the *Colonial Report* for 1929 has utilised several methods in the past in all parts of the territory to combat the continual erosion of the soil by donga formations with the purpose to instil into the native mind the loss of the richest soil that dongas continually and increasingly caused. Unfortunately, as was the case in other agricultural matters, it was found that the natives derived little benefit from this instruction; and it was seldom that any attempt was made in their own villages to carry out the instructions. Hence, after considerable thought and in the light of experience gained, the Department made a thorough alteration in its instructional methods. Briefly, under the new plan, the native was taught better methods of agriculture viewed as a whole in the hope that a knowledge of the whole subject would encourage and enable them to realize the real importance of donga prevention. For this purpose a number of native demonstrators have since been employed, who give lectures and ocular demonstrations, so that the people may take a livelier interest in a subject of so much importance to them. They are shown the value of planting suitable trees where dongas have already formed, and the danger of careless ploughing and of having many needless cattle paths on lands that is as yet free from erosion. In spite of all this, however, there is no definite improvement to be reported, and fresh dongas are continually being formed and allowed to grow, without any effort on the part of the native to combat their progress.

Belgian Congo.

The *Revue Internationale des Produits Coloniaux* states that after about 15 years of neglect Congo coffee is beginning to come into favour on the market. The missionaries were the first to take up the cultivation; now in the Eastern Congo there are many coffee planters and their number is yearly increasing. The future of Belgian coffee lies in the Kivu and Ituri areas. The climate there is good, access is easy to the sea *via* Uganda and Kenya, there are railways and many roads in course of construction, while a large population makes the labour problem an easy one.

The quantity of Congo coffee imported to Antwerp only (not counting that sent elsewhere) was 10,000 bags (of 110 lb.) in 1928 and 40,000 bags in 1929; for 1930 the amount is expected to be 100,000 bags and for 1935 about 300,000 bags. In 1926 the area under coffee was estimated at about 8,900 acres, *robusta* being planted in the lower country but *arabica* in Kivu and Ituri. For 1929-30 the acreage is expected to reach 25,000 acres.—(*East Africa*, Vol. VI, No. 289.)

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Tongan Islands.

According to the Colonial Report for 1929 the early history of these islands is enshrouded in myth, and any attempt to reconstruct the past is based on the list of the Tui Tonga, the ancient kings. The extent of the dominions of these ancient kings is not clearly known, but there is evidence that they possessed overlordship over a vast area of Polynesia, whence they received tribute. Evidence remains in modern Tonga of the power of the ancient kings in the form of the stone monuments which still exist. Chief of these is the Haamonga—a trilithion consisting of two large coral upright stones about 16 feet high, with a connecting stone, 19 feet long, laid horizontally across and mortised into the tops of the upright pieces the visible parts of which are estimated to weigh between 30 and 40 tons. It was probably erected about the thirteenth century. Tradition is not consistent as to the reason which impelled the then Tui Tonga to erect this monument, but it is evidentiary of an absolute power. Its state of preservation is excellent. Other evidence of the powers of the ancient kings is to be found in the langis, the royal burial grounds, which still exist in Tonga. They consist of quadrilateral mounds, faced by huge blocks of stone, rising sometimes in terraces to a height of 20 feet. The stones are coral, of immense weight, and can only have been placed in position by the concerted labour of a large body of men skilled in the use of rollers and levers. The stones out of which the monuments were constructed were probably quarried from the coral reefs, though there is a strong traditionary evidence that many of them came from distant Polynesian islands.

Copra is the sole agricultural export. Prior to the War there was a considerable fruit trade with New Zealand but the absence of direct

ACADEMIC STAFF AND STUDENTS, 1930-31.

Sitting left to right.

1ST ROW:—W. H. BECKETT; TUNKU YACOB; F. A. SQUIRE; M. F. ROSE; G. D. P. OLDS; J. C. EYRE; E. M. COOK; J. G. BRASH; M. C. M. BRIDGES.

2ND ROW.—J. L. GOELLNICHT; H. L. MANNING; L. C. W. GREAVES; H. C. MILLER; G. C. BOURNE; M. BARCANT; ST. GEORGE COOPER; J. SINGH; S. A. SCHOUTEN; T. E. K. POTTER; J. M. MCEWEN; J. M. CAVE.

3RD ROW.—L. A. CORBIN; G. G. GIANETTI; R. E. HUNTER; H. V. M. METIVIER; E. E. CHEESMAN; R. C. WOOD; H. R. BRITON-JONES; H. A. BALLOU; G. EVANS; F. HARDY; C. Y. SHEPHARD; E. A. SEAGAR; A. G. HOWELL; P. E. TURNER; F. W. URICH.

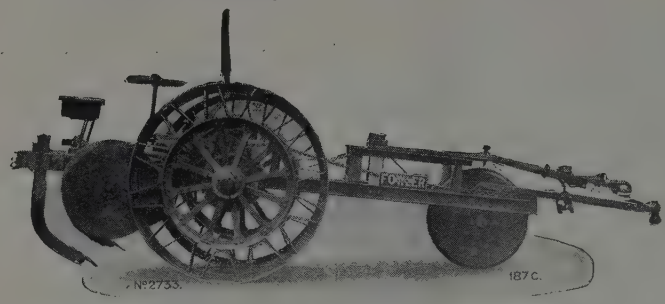
Standing left to right.

1ST ROW.—L. E. W. CODD; L. N. H. LARTER; E. PARRY-JONES; W. J. M. IRVING; J. D. JAMESON; J. A. BAKER; D. H. BROWN; A. J. MCDONALD; H. H. CROUCHER; J. G. DAVIES; J. G. MYERS; E. E. PYKE; F. J. POUND; A. PICKLES; W. A. TANSLEY; L. D. CLEARE.

2ND ROW.—I. W. M. ARMSTRONG-BLACK; J. E. P. BOOTH; W. T. DALGARNO; A. F. NICHOLS; C. A. S. HYNAM; J. F. WILLIAMS; W. J. BADCOCK; G. B. GREGORY; G. V. WICKRAMESEKERA; J. DE LABASTIDE; J. A. WIRSHING; T. G. STRANGEWAYS; W. F. GUILLIAM; T. A. RUSSELL; R. E. T. HOBBS; R. T. WIGLESWORTH; L. DE VERTEUIL.

3RD ROW.—H. B. STENT; J. G. M. KING; J. N. CLOTHIER.

Subsoiling for greater crop-yield



THE secret of good cultivation for ratoon cane has been found in deep subsoiling. It stirs up the soil and reinvigorates the cane stools, while the surface layer of trash remains to retard evaporation and weed growth. Subsoiling *definitely* increases the yield of canes, in reported cases as much as 100%. The letter below, from the Colonial Sugars Co., of Cuba, shows that subsoiling with the Fowler Patent Combined Trash Cutter and Ratoon Subsoiler is indeed a very profitable operation.

2nd July, 1921.
"The two previous crops from this land had given very poor results, only yielding 15 tons to the acre. The total cost of subsoiling was $3.00 per acre, including all charges against steam ploughs. The result of the operation was that the fields yielded 25 tons per acre at the next crop, and have done the same each year up to the present."

NOTE—In the above case, also the profitable life of the ratoons was doubled (from 5 to 10 years).

Write for fullest information of the

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Combined TRASH CUTTER and RATOON SUBSOILER

Working on the cable system with Fowler Steam, Petrol or Diesel Motor Engines.

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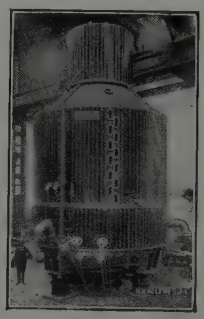
are designed for rapid circulation with well-proportioned and distributed heating surface and a corresponding economical steam consumption. MIRRLEES EVAPORATORS and VACUUM PANS are used throughout the world and are known for their unfailing service.



15' 0" dia. Inclined Calandria Vacuum Pan.

Quadruple Effect Evaporator.

The MIRRLEES WATSON COMPANY LIMITED

ENGINEERS, Scotland Street, Glasgow

London Office:
7, Grosvenor Gardens, S.W.1

communication with the Dominion, which ceased during the War, has killed the trade. The soil throughout the group is very fertile and in Tongatabu European vegetables of most summer varieties are easily grown except during the hot months of December to April. Native root crops, of excellent quality, are produced in abundance for domestic use. Copra production is almost entirely carried out by the Tongans, there being only a few European planters in the islands. Every Tongan landholder, as an incidence of land tenure, is under obligation to plant half of his holding in coconuts. Provision is further made that the trees should be properly spaced, 30 feet apart, and planted in rows. Legislation also exists having for its object the improvement in the quality of copra produced and it is an offence for a trader to have in his possession bad or damaged copra.

* * *

Dutch East Indies.

The economic life of Netherlands India is closely tied up with agriculture, and there has been a slump in the world prices of those commodities which constitute the greatest source of profit to this country. Although the milling season for sugar is long past, there was still an unsold stock of 180,000 tons of the 1929 crop early in 1930. Both sugar and coffee production for the past three years have been greatly in excess of consumption. The removal of the import duty on tea entering the United Kingdom has rendered the inferior grades of Netherlands India more competitive with British India teas. At present there is, in theory, an agreement between producers of India, Ceylon, and Netherlands India to restrict production by 10 per cent. Rubber is the most seriously affected product of all. Maize, cassava, groundnuts, and similar native field crops have suffered from drought, and the production of rice fell off, making heavy importations necessary.

* * *

Jamaica.

In his report on the trade of the Colony during the financial year ended 31st March, the Collector-General of Jamaica states that revenue from import duties not only exceeded £1,000,000, but also exceeded the high mark achieved in 1928-29. Collections totalled £1,196,334, against £1,136,171 in the previous year. The value of goods imported during the year was £6,746,095, manufactured articles being responsible for 48.3 per cent. of the total, and food, drink, and tobacco for 30.5 per cent. While preference may be only one of the many factors which cause changes in the direction of trade, there has been a great increase in importations from Empire sources.

Exports during the financial year reached a value of £4,649,130. Bananas represented 54 per cent. of the total, sugar coming next with 10.4 per cent., and pimento third with 7.5 per cent. The United Kingdom has absorbed an increased percentage of island products. In 1929, 4,025,673 stems of bananas (18.3 per cent.) were sent to England, against 2,766,039, or 16.2 per cent., of the output during the previous year. There is, the report proceeds, a continuous tendency to decline in the case of purchases by the United States of America, which bought nearly 1,000,000 stems of bananas fewer during 1929.

* * *

Nigeria.

According to the Colonial Report for 1929 the prices of all agricultural export commodities from Nigeria have been generally low and tending to fall still lower during the year under review. It is recorded, however, that with one exception the volume of the export of these products had slightly increased, palm kernels constituting the exception. The exports for 1928 and 1929 were as follows :—

	1928.		1929.	
	Quantity Tons.	Value. £	Quantity Tons.	Value £
Palm Oil ..	127,110	3,816,658	131,786	3,767,279
Palm Kernels	246,537	4,562,105	251,368	4,325,877
Groundnuts	103,162	1,650,134	145,376	2,467,470
Cocoa ..	49,209	2,309,931	55,246	2,305,574
	Cwts.		Cwts.	
Cotton Lint	74,957	379,490	117,803	541,713

Average prices for palm kernels fell from £15 8s. 0d. in 1928 to £13 8s. 0d. per ton in 1929, for palm oil from £24 4s. 0d. to £23 13s. 0d. and for groundnuts from £12 18s. 0d. to £11 0s. 0d.

Figures for exports of cocoa from Nigeria and the Cameroons reveal that the production of cocoa in Nigeria had increased from 42,000 tons in 1927-28 to 49,000 tons in 1928-29, and in the Cameroons from 3,500 tons to 3,700 tons. Apart from a few hundred tons the exports from the Cameroons represent the production of estates while the Nigerian crop is grown entirely by native peasants. The volume of exports of cocoa from Nigeria was considerably greater than ever before, and there is every reason to believe that this represents mainly a permanent advance in production due to an increased area of bearing cocoa. The quality exported was also extremely satisfactory in so far as freedom from decayed beans and dryness were concerned. In 1928-29, grading, according to the content of fermented beans was first introduced as part of the produce inspection system but it was found that the grades, when interpreted with the strictness necessary in official grading, were altogether too high for West African cocoa. In 1929-30 new grades were fixed and more accurately defined.

The export of groundnuts represents the highest figure on record and the present increase consists largely of the production of the new areas opened up by the Gusau branch railway. It is reported that the area of country in which cotton is grown for export has also continued to expand. The production of improved cotton continues to progress satisfactorily, 920 bales of this being exported as against 48 in 1927-28.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Malaria and Cinchona Alkaloids.

Cinchona bark was introduced into Europe some three hundred years ago for the treatment of malaria. The bark contains four principal alkaloids, namely quinine, quinidine, cinchonine and cinchonidine, which together form the cinchona group. In 1820, quinine was isolated from the bark and its value was immediately realized. It has been assumed that quinine has a therapeutic value in the treatment of malaria superior to that of the other three alkaloids subsequently isolated from the bark, and practically all recent malarial control work has been associated with this alkaloid alone. The other members of the group, although possessing chemical structures closely related to that of quinine, and, therefore, it might be anticipated, similar therapeutic action, have been almost neglected. The result has been that the agriculturist cultivating cinchona has been encouraged to grow varieties which, though less hardy than the normal varieties, have been bred to produce a high yield of quinine. Proof that the other alkaloids of the group are greater or equal in value to quinine in the treatment of malaria would enable him to grow the more hardy varieties of cinchona which yield a mixture of the four alkaloids.

The neglect of these cinchona alkaloids has been largely due to the difficulties associated with testing the relative values of the drugs. Reliable results could be obtained only after extensive clinical trials in malarial countries. Recent investigations have shown that birds, which share with man susceptibility to malaria, can be used for making the necessary tests. Workers at the Wellcome Chemical Research Laboratories, London, and the London School of Hygiene and Tropical Medicine have recently performed tests on birds suffering from malaria not only with the alkaloids from cinchona bark but also with a large number of their chemical derivatives. Their results show that hydroquinine, a reduction product of quinine, is far more effective in action on malaria than any of the original alkaloids. The activity of the alkaloids is, in the descending order, quinidine, quinine, cinchonidine, cinchonine, though there is little to choose between the four. Reduction of quinidine, cinchonidine and cinchonine, however, does not appear to lead to increased activity as it does in the case of quinine. Although it cannot be considered that final conclusions have been reached, the results seem to show that bark containing a high proportion of quinine will be in demand for the production of hydroquinine. In present circumstances, however, the mixture of alkaloids produced from the hardy varieties of cinchona is nearly equal in value to pure quinine.

Other drugs than cinchona which have a reputation as remedies for malaria, such as Alstonia bark in West Africa and the Far East, and greenheart bark in British Guiana, were also tried. Only the alkaloids from the Alstonia showed any activity in bird malaria.—(*Biochem. Journ.* XXIV, p. 874.)

* * *

The Preparation of Fruit for Transport.

A process has been developed by an American Company for hermetically wrapping fruit before transport. The picked fruits are completely immersed in a viscose solution. Mechanical devices ensure that they have a complete and uniform covering of solution. The fruits are then passed successively through a curing bath of ammonium sulphate solution in which the viscose covering is set, through a bath of dilute sulphuric acid to render the covering clear and transparent, and finally through a washing bath of water containing a little glycerin. The final coating is then dried in a current of air which causes it to shrink closely on to the fruit. The fruit now possesses a tightly fitting, air-tight, transparent covering, and may be packed for transport in the usual way.

The equipment for the process consists of the usual apparatus for the production of viscose solution from waste cellulosic material, of the necessary tanks, and of the mechanism for the transport of the fruit from one bath to the next. During the whole process the fruit is not touched by hand.

Many advantages over the paper wrapping method are claimed for the process. The viscose film protects the fruit from bruises far more efficiently than a paper wrapper. The wet film, sticking on to the fruit, tends to seal the pores of the skin, thereby preventing loss of moisture and the entry of bacteria. The viscose solution also acts as a sterilising agent. Any slight damage to the surface of the fruit is thereby prevented from increasing. The sealing of the pores also prevents further ripening of the fruit. Fruit may therefore be allowed to ripen on the tree before picking and may still arrive at its destination in a good condition. Evaporation of essential oil from the skin is prevented and the flavour of the fruit is enhanced.

If it is considered that the fruit should "breathe" during transport, compressed air, blown into the viscose bath, pierces the viscose skin with numerous pin holes.

At present the process is chiefly applied to fruits of regular shape such as oranges, grapefruit and melons. It is hoped, however, to modify it to enable the successful treatment of such fruit as pineapples. If the claims of the process can be substantiated its use in the transport of such tropical fruits as mangoes and pawpaw should be invaluable.—(*Ind. Chem.* p. 415, 1930.)

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Presence of Non-Sugars in Sugar Crystals and their Effect on White Sugar Production, by *P. Honig.*

The presence of non-sugars in consumption sugars is due to the fact: (1) that the adhering molasses is not wholly removed from the surface of the crystals; and (2) that non-sugars are absorbed by the crystals during crystallization. That the impurities which are syn-crystallized may be of importance appears from the fact that first sugars obtained from the boilings either by graining on thick-juice (evaporator syrup), or by using double purged after-products to start crystallization, show considerable differences in purity. Such differences do not so much affect the general appearance of the sugar as much as its "internal properties," *i.e.*, its ash content, reducing compounds, &c. To obtain some insight into what may happen in syn-crystallization, molasses massecuites were allowed to crystallize until equilibrium between sugar and mother-liquor was reached. They were then spun off, and the after-product sugars pugged with pure saturated solutions of sugar to remove the adhering molasses. After five hours the sugars were again spun off, again mixed with pure saturated solution, and again centrifuged, these operations being repeated till the liquors spun off became equal to the original pure saturated solutions used. Then the original massecuites, the spun-off molasses, and the washed sugars were fully analysed, the following being some observations made from the tabulated figures obtained:—

(1) The sugars obtained contained comparatively large quantities of non-sugars, their pol. being 99° at 30° C. (2) The sugars contained twice as much ash as reducing sugars, whereas in the original massecuites the ash was only a fraction of the reducing sugars content. (3) Whereas again the lime content of the ash of the original massecuites was about 10 per cent., the ratio had increased in the sugars to about 20 per cent. And (4) the sugars contained only about $\frac{1}{4}$ amount of the iron originally present in the massecuites. It was also shown that the sugars from sulphitation factories contained considerably more colouring matter than those from carbonation factories. Such adsorption of certain substances, lime salts for example, can be explained by assuming that these combinations do not occur any longer in the molecular form in the mother-liquors during crystallization, but are precipitated in the colloidal state, being taken up in the interior of the crystal. Several investigations of the last few years seem to point to the crystallization process not being a transference of molecules from the solution towards a solid wall, and one can distinguish at first the formation of polymolecular groups, or "submicrons," which later unite into large crystals. Polymolecular deposition on a crystal surface has been convincingly discussed by Volmer.* Modern ideas such as this about the formation of crystals can furnish a satisfactory explanation of the way in which non-sugar is taken up into the sucrose crystal. There is of course always the possibility of the formation during the boiling process of precipitates, which adhere to the surface of the crystals, but in these experiments special care was taken to remove these adhering impurities.—(*International Sugar Jr.* Vol. XXXII, No. 383.)

* * *

P.O.J. 2878 Cane in the Philippines.

P.O.J. 2878 has made a wonderful cane growth in nearly every district in which it has been tried in the Philippines, and has been received with much enthusiasm by the planters, but a note of caution is sounded concerning the further planting of this variety until more is known about it, as so far it has exhibited three rather serious defects.

(1) It has given poor juices.

(2) It tassels commonly in October or November.

(3) It is so tall that it is easily knocked down by strong winds or heavy rains.

Concerning the first point, careful experiments in Java have shown that P.O.J. 2878 requires 15 months for optimum maturity and that moderately good juices can then be obtained. Although average crops in the Philippines are 12 months old or less, it is possible to increase the growing period to 13, 14, or even 15 months, in which case it should give as good juice qualities as in Java.

As regards tasseling, reports indicate that Java is also experiencing difficulty with P.O.J. 2878 in tasseling, this year more than last year. There is some evidence that this tasseling can be minimized by careful and discreet applications of small quantities of nitrogen fertilizers in the month of August. Applications of 100 kilos of ammonium sulphate, or better still, 120 kilos of nitrate of soda, per hectare, should be experimented with on a small scale.

It is possible that injury resulting from the lying down of P.O.J. 2878 is exaggerated. P.O.J. 2878 has a very hard rind and therefore when lying on the ground will not suffer from rat injury and rotting as seriously as softer varieties do.

Although P.O.J. 2878 has shown the foregoing disadvantages in the Philippines, it has also developed hitherto unknown advantages. It is known to be very resistant to mosaic disease, to leaf scald, and also, because of its hardness, to rat injury. In addition, it has developed that P.O.J. 2878 is the most resistant to standing water of any of the Philippine varieties, and since standing water is one of the most injurious factors on the lowlands of Negros, this one character probably will more than compensate for its disadvantages, which can to some extent be remedied.—(*Facts about Sugar*, Vol. XXV, No. 23.)

* *Zeitsch. Phy. Chemie.* 1926, 119, 46.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign. s.	d.
30th October	6	5¼
6th November	6	6
15th November	6	3
22nd November	5	6
29th November	6	0
6th December	6	0½
10th December	6	6
Preferential has remained at	9	4½

According to *Messrs. C. Czarnikow Ltd.*, the chief interest in the sugar world has been focussed on events in Cuba in connection with the scheme put forward by the Chadbourne Committee. Conflicting rumours and reports as to its ultimate fate have influenced prices which have fluctuated erratically without definite trend. The general uncertainty as to the future of the article appears to have almost completely checked enterprise in the important consuming countries of the world, whilst supplies on hand and sugars already contracted for are apparently ample to meet current needs and permit the larger buyers to hold aloof from the market until present developments assume more definite shape. The attention of the trade is being directed to the Conference of the Java and European Sugar producers which will also be attended by Mr. Chadbourne and the Cuban delegation.

* * *

COCOA.—Spot cocoas are in good demand due to the continued holding up of supplies of new crop by the West African farmers. Despite the holding of meetings between the Accra Chamber of Commerce and the representatives of the Growers' and Farmers' Federation no break is yet apparent. At the present time, with an unwilling market, prices are being kept as low as possible for as long as it is possible.—(*By courtesy of the Cocoa Planters' Association of Trinidad.*)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—29th October, $4\frac{7}{16}$*d.*; 5th November, $4\frac{15}{16}$*d.*; 15th November, $4\frac{1}{2}$*d.*; 22nd November, $4\frac{5}{8}$*d.*; 29th November, $4\frac{9}{16}$*d.*; 6th December, $4\frac{5}{8}$*d.*; 10th December, $4\frac{3}{4}$*d.*

There has been a distinct improvement in the tone of the Rubber Market. Up to the middle of November prices remained firm. One of the causes which contributed to this improvement has been extensive buying of Spot Rubber by French interests. There has also been some fairly good American buying and some trade enquiry from both British and Continental manufacturers. Figures of Dutch East Indies shipments for October show a falling off in both Estate and native rubber.

* * *

COTTON.—The following are the official spot prices in pence per pound of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
17th Oct.	5·73	9·55	23·00	37·00	26·00-26·50
24th Oct.	6·05	9·65	23·00	37·00	—
31st Oct.	6·24	9·95	23·00	37·00	22·00
7th Nov.	6·03	9·85	23·00	37·00	23·75-24·00
14th Nov.	5·98	9·70	23·00	37·00	—
21st Nov.	5·98	9·60	22·00	37·00	20·00
10th Dec. (local)	5·63	—	—	—	—

There appears to be a sounder undertone all round which can only be explained by the fact that the recent slump in values was largely due to the weakness in outside commodities and not to the question of cotton pure and simple.

* * *

TEA AND COFFEE.—There has been a slow but very regular upward movement in tea prices. Latest averages according to the *Times Trade and Engineering Supplement* (29th November), include Ceylon, 18.89*d.*; Indian, 14.51*d.*; Java, 11.42*d.*

British East African trade in coffee is very progressive and has largely replaced not only *Abyssinian but Mocha.* New Costa Rica have met a rather slow demand. Brazilian quotations are lower : Santos 50*s.*, Rio 34*s.*, cost of freight.

* * *

COPRA.—According to *Gillespie Bros. & Co.* there has been an erratic market, the value declining at one time to £16 for West India. Latterly the tone has become firmer, buyers being more interested, £16 15*s.* c.i.f. being the value of December shipment.

* * *

BANANAS.—Jamaicas are in slow demand and unchanged to wholesalers at £21 delivered (London), and £20 10*s.* delivered nearest railway station ; the price to retailers is 10½*d.* per dozen. Brazilians are weak and unaltered at £20 per ton delivered nearest railway station.—(*West India Committee Circular*, 27th November.)

* * *

LIME PRODUCTS.—*Lime Juice.*—According to *Messrs. Gillespie Bros. & Co.* there is at present no demand for raw juice, good green on the spot being held for 3*s.* Concentrated is extremely depressed and recent arrivals have been sold at £8 10*s.* per pipe, c.i.f., basis 64 oz. *Lime Oil* is quiet, distilled was last dealt with at 31*s.* per lb. c.i.f.